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Planning, Designing and Erecting Transmission Lines*

Economic Considerations in Laying Out Line—Preliminary Work of Great Importance—Locating Supporting Structures—Methods of Erecting and Anchoring Steel Towers — Setting Wood Poles

By ALFRED STILL

Wood poles and steel towers for transmission lines formed the subject of a preceding article, but matters such as the laying out of an overhead line, the placing of the supports and their erection, were not discussed. It is not proposed to describe in detail the actual erection of transmission line supports in the field, but there are engineering features of transmission line construction which should be referred to in this series of articles and to which attention will now be drawn.

Assuming that it is proposed to transmit energy electrically from a point where the power can be cheaply generated to an industrial or populous center where there is a demand for it, a straight line drawn on the map between these two points will indicate the route which, with possibly slight deviations to avoid great differences in ground level, would require the smallest amount of conductor material and the fewest

*Preceding articles in this series appeared in our issues of July 17, Aug. 7, Aug. 21, Sept. 4 and Sept. 18.

130,000-Volt Transmission Line of West Penn Power Co.—Towers Spaced 550 Ft. Apart.

poles or supporting structures. There may be natural obstacles to the construction of so straight a line, as for instance, lakes that cannot be spanned, or mountains that cannot be climbed; but even the shortest route which natural conditions would render possible is by no means necessarily the best one to adopt. The right-of-way for the whole or part of the proposed line may have to be purchased, and the cost will often depend upon the route selected. By making a detour which will add to the length of the line it may be possible to avoid crossing privately owned lands where a high annual payment may be demanded for the right to erect and maintain poles or towers. Again, by paralleling railroads or highways, the advantage of ease of access for construction and maintenance may outweigh the disadvantage of increased length. A slightly circuitous route may take the transmission line near to towns or districts where a demand for power may be expected in the near future; such possibilities should be taken into account. The engineer in charge of the preliminary survey work should bear all such points in mind and compare the possibilities of alternative routes. On a long and necessarily costly transmission line, it is rarely possible to spend too much time and thought on the preliminary work which will result in ultimate economies.

Economic Considerations.

Without going so far as to say that the most costly transmission line is likely to be the cheapest in the long run, it is nevertheless of the utmost importance that all overhead construction that is not merely for temporary use should be planned with as much care and designed with as much attention to the principles of sound engineering as are usually devoted to the construction of an important railway bridge or any other engineering undertaking of permanent value to the community. It is not always the engineer who should be held responsible for failure to provide a proper return on capital invested; he may be an experienced and competent man of sound judgment, whose executive power has been unduly limited. On the other hand, if he is unfamiliar with this phase of electrical engineering, the question arises as to whether he should have been employed at all. Generally speaking, the writer believes that not enough attention has been paid in the past to the planning and preliminary estimates and calculations in connection with overhead transmission lines. The construction of comparatively short lines for moderate voltages appears to be, and indeed is, a fairly simple piece of work, yet, from the economic viewpoint, such lines may be very far from satisfactory.

The setting out and erection of the supporting structures of an overhead power line will depend upon the nature of the supports, the character of the country, the transit facilities and many other conditions which will naturally modify the procedure. In the case of a steel tower line of medium voltage, say 60,000 to 110,000 volts, the usual procedure may be summed up very briefly as follows:

Obtain the best maps available of the district through which the line will pass and sketch upon them one or two possible routes. It is not always the shortest line that is the most economical to construct.

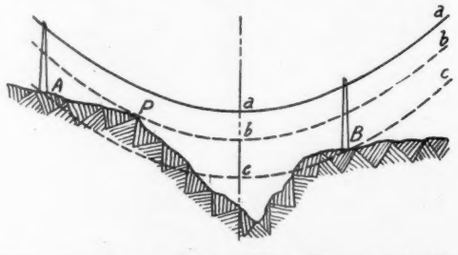
The engineer, provided with a note book and perhaps with a prismatic compass, should now drive, ride or walk over the tentative routes. He should be an electrical engineer with experience in this kind of work. Having thoroughly covered the country and decided upon the route which appears the most suitable, he should lay this out approximately on the map. In most cases it will pay to follow up this work by sending out a surveying party to obtain more detailed particulars needed by the engineer.

The next step is to send a surveying party into the field to stake out the approximate position of each tower and indicate where clearing has to be done. (The width of clearing must be such that trees cannot be blown down so as to fall across the wires.)

When this work is finished the engineer who will take charge of construction should go over the line as staked out, and if he is a competent man experienced in transmission line work he should be permitted to modify the position of the towers to improve the grading or avoid awkward corners, etc., as his judgment may dictate; his suggestions to be agreed by the engineer in charge.

Much of this work may seem unnecessary and unduly costly, but the writer is of opinion that ultimate economy is generally obtained by spending more rather than less money than is customary on this preliminary work.

When there is doubt as to the proper location of the supports in rough country, the method illustrated in the accompanying diagram will be found convenient. The curve *a* is the parabola or catenary corresponding to the required tension in the particular wire to be used. The ratio of the scale of feet for vertical measurements to the scale for horizontal measurements should be about 10 to 1. The dotted curves *b* and *c* are exactly similar to *a*, but the vertical distance *ab* represents the minimum allowable clearance between conductor and ground, while the vertical distance *ac* is the height above ground level of the point of attachment of the lowest wires to



Template for Use in Determining Proper Location of Supporting Structures.

the standard transmission pole or tower. These curves should be drawn on transparent paper; they can then be moved about over a profile of the ground to be spanned, drawn to the same scale as the curves, until the best location for the supports is found. The point *P* where the curve *b* touches the ground line is seen to be far removed from the lowest point of the parabola, in the example here illustrated. A little practice will make the finding of the points *A* and *B* an

easy matter, even if the length of span, or distance between *A* and *B*, must be kept between close limits.

This method is particularly applicable to long-span lines carried over rough country.

Erection of Steel Towers.

Towers are usually assembled in a prone position and then raised to the vertical position by swinging them about two hinge points which may be near to, or actually on, two of the anchor stubs which have previously been set in the ground or the concrete base. A crew consisting of one foreman with eight or ten men will generally be required to erect towers of the rigid, square-base type. Once the erection equipment has been rigged up and the erection shoes or struts have been bolted in place, the actual raising of the tower is accomplished with the aid of horses, or preferably, when conditions are favorable, with a caterpillar tractor.

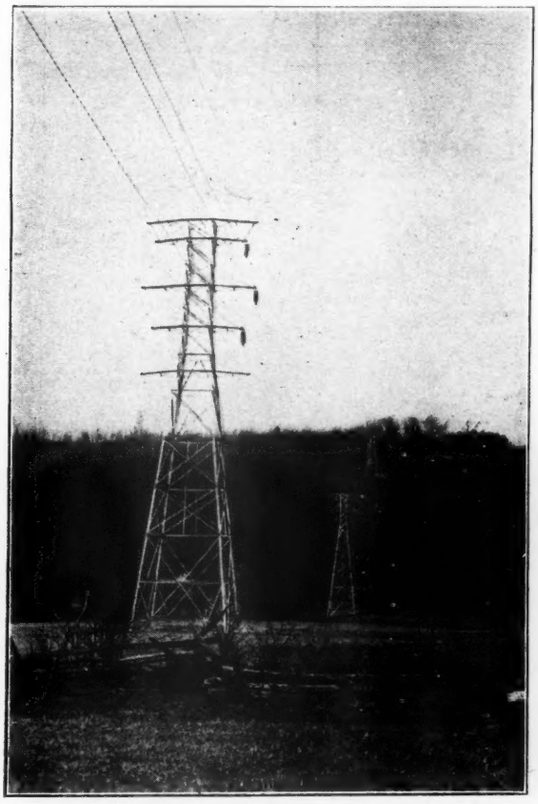
An alternative method of erecting towers consists in assembling all the members one at a time in their proper positions, the smaller members, after the post members have been erected, being pulled up by means of hand lines. A crew consisting of a foreman and six or seven men will be required for erecting the larger towers by this method.

Since the upward pull on the footings of the rigid type of steel tower may be considerable, the type of foundation and method of anchoring should receive careful attention. When concrete is used, a separate footing is provided for each of the corner members, and the anchor stubs, to which the superstructure is bolted, extend into the concrete footings. Sometimes the post section is provided with a steel base plate which rests upon the top of the concrete footing and is fastened thereto by long belts imbedded in the concrete. If concrete is not used, the footing must be so designed that there is enough bearing surface between the footings and the earth to resist the crushing stress under maximum load conditions, and also to provide for a sufficient mass of earth above the footing to prevent the uprooting of the tower before the stress in the tower members has reached its maximum limit. It is advisable to design the footings so as to resist an upward pull about 25% in excess of what corresponds to the ultimate or specified limiting load on the tower.

The weight of concrete may be taken at 140 lbs. per cu. ft., and of good earth at 100 lbs., the volume of the earth to be lifted being calculated at the angle of repose, which may be about 30 or 33 deg. with the vertical. If the footing of a tower is in gravel, or a mixture of sand and loam tightly packed, there is actually a far greater resistance to the pulling up of the footings than that which is offered by the mere weight of the footings with prism of earth as calculated in the usual way.

When concrete has to be used, it is generally cheaper to reinforce it with steel of an inverted "T" form, as this makes a lighter construction than a solid block of concrete, and an equally good hold is obtained, owing to the increased weight of the packed earth which has to be lifted. At the same time it must not be forgotten that the digging of a large hole 5 to 8 ft. deep is considerably more costly than the digging of a hole about 2 ft. square, and this extra cost in erection must be taken into account in designing the footings.

In marshy or loose soil, or where the right of way is liable to be flooded, special attention should be paid to the design of durable foundations. Concrete footings with or without piles, or rock-filled crib work may be necessary; it is a matter requiring sound judgment and, preferably, previous experience on the part of the engineer in charge of construction. Crumbling hillsides are best avoided; it is extremely difficult to guard against damage by landslides or even snowslides when towers are erected on the steep slopes of hills.



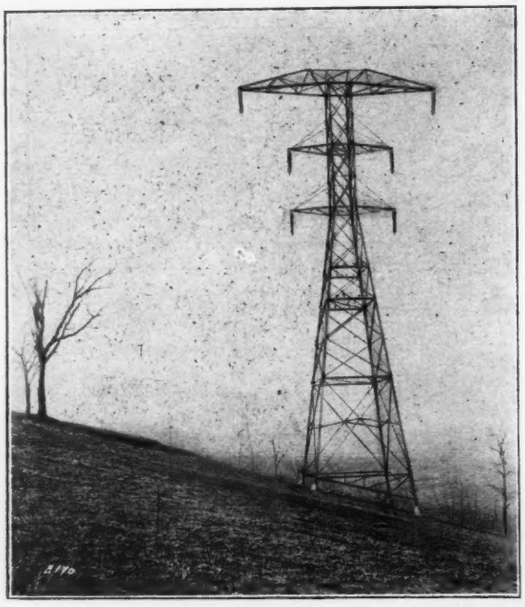
High-Voltage Transmission Line Towers Supporting Two Three-Phase Circuits and Two Ground Wires.

The use of concrete adds considerably to the cost of foundations, but, on the other hand, it is not easy to design foundations without concrete to resist a given uplift without an exact knowledge of the soil conditions at the site of the tower. For the greatest economy of foundation it is necessary that the designer obtain reliable information on this point.

When concrete is not used, the design of the anchors is a matter that should receive careful consideration. If towers are to be subjected to load tests, these tests should, if possible, be conducted on a tower set on its own anchors, as used in the field, because the strength is to an appreciable extent dependent upon the method of attachment of the tower legs to the anchor stubs.

Another point of importance is the surface of the footing in contact with the earth immediately

above it. The weight of the cone of earth to be lifted may be ample to provide the desired factor of safety, but movement of the tower foundations may occur through the packing of the earth due to excessive unit pressure over the upper surface of the footing, and this movement may be



Blaw-Knox Steel Transposition Tower on West Penn Power Co.'s 130,000-Volt Lines.

appreciable notwithstanding that there may be no disturbance of the ground surface. A surface of not less than 1 sq. ft. for every 10,000 lbs. of the vertical force which will pull out the anchors should be provided unless the nature of the soil is such as to justify a reduction of this allowance.

Setting Wood Poles—Guy Wires.

In a preceding article dealing with transmission line supports reference was made to the depth of holes for wood poles and also to special machines now used for drilling holes and erecting poles.

Loam and gravel, and even sand, or a mixture of these, provides a firm foundation for poles. A pole that is properly set should break before the foundations will yield to any appreciable extent. Even if there should be a movement of the pole butt in the ground with excessive horizontal load at the pole top, this will usually result in a firmer packing of the earth, which will then be better fitted to resist any further movement.

Firm sand, gravel or loam will withstand a pressure of about 4 tons per sq. ft.; but only half this resistance should be reckoned on in the case of damp sand, moist loam or loose gravel.

Proper supervision is necessary to ensure that the earth shall be packed firmly around the pole when refilling the holes.

In order to reduce the stresses, not only on the pole itself, but also on the insulator pins and crossarms, it is usual to shorten up the spans on each side of the corner pole. The reduction in length of span will depend upon the amount by which the direction of the wires departs from the straight run. A rough and ready rule is to reduce the span length 1.5% for each degree of deviation from the straight line. For angles less than 5 degrees it is not necessary to alter the span.

It is not advisable to turn more than 25 degrees on one pole, and whenever the side strain is likely to be excessive, double crossarms and insulators should be used. By giving proper attention to the matter of guying and to the mechanical construction generally, it is not difficult to meet all requirements at points where a change of direction occurs.

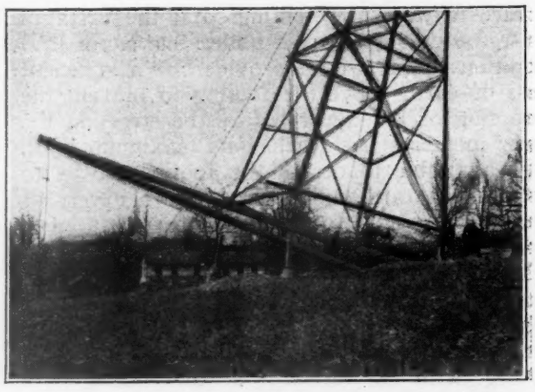
A safe plan is to assume that a corner pole must carry the full load without breaking if the guy wire or wires should fail to take their proper share of the load; but all corner poles should be propped or guyed for extra safety, and to avoid the unsightly appearance of poles bent under heavy side stresses or set at an angle with the vertical.

Sometimes when sharp corners have to be turned, the spans on each side are "dead-ended" on poles with double fixtures. Such poles are head-guyed, and the span adjoining the guyed pole is usually shortened, being not more than three-fifths of the average spacing.

Guy wires should be of galvanized stranded steel cable, the breaking strength of which should preferably not exceed about 34 tons per sq. in. The reason for this limitation of strength is that the high-strength steel is usually too hard to allow of proper handling and finishing off.

When erecting poles in soft soil one or more transverse logs are sometimes bolted to the butt of the pole to provide additional bearing area and prevent movement of the pole in the ground.

In swampy ground the base of the pole is sometimes provided with an arrangement of transverse timbers securely braced to the pole, in addition to which the hole may be lined with sheet piling and filled with good soil which may contain stones or rock. As an alternative, a stone or rock-filled crib may be built round the butt of the pole above ground level. In some cases con-



Method of Erecting Steel Transmission Line Towers.

crete is used with advantage in the pole foundation, but it will generally be found that the use of concrete can be avoided.

Use of Guy Wires on Steel Towers.

Poles should not be set along the edge of cuts or embankments or where the soil is liable to be washed out, unless special precautions are taken to ensure durable foundations.

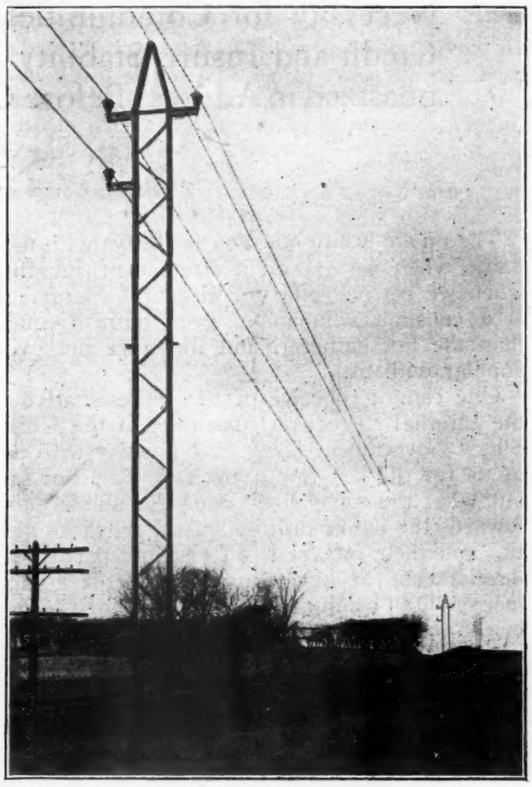
Guy wires are occasionally used in connection with steel poles and light tower structures. The

"A" frame or "Flexible" type of steel supporting structure is sometimes guyed, especially when the line turns a small angle on a single structure and also at intervals of 0.5 and 0.75 mile on long straight runs. Strain towers are built for turning corners of 90 degrees, but when possible it is usually preferable to take care of sharp deviations in the line by using two or more corner towers, each one being used for a deviation of about 30 degrees.

It is not customary to use steel guys in connection with the larger transmission line structures, these being generally designed to resist the maximum stresses to which they may be subjected even under abnormal load conditions. There is, however, no apparent reason why economy in material of corner structures and strain towers generally might not more frequently be effected by using the tower proper as a compression member only, and taking the tension components of the total force acting on the structure by means of one or more steel cables disposed as guys and firmly anchored in the ground at such a distance from the base of the tower as may be most convenient and economical in material.

It is true that, with the so-called rigid design of tower, a very small deflection at the point of attachment of the guy wire may be sufficient to produce permanent deformation of the structure and there is a possibility that the tower may collapse under excessive load before the guy wires have taken up their proper share of the abnormal stresses. This is especially likely to occur if the towers are set on concrete foundations. On the other hand, it is not impossible to design towers of the square-base type with foundations purposely arranged to yield slightly; and if these structures are provided with guys (say of plow-steel cables) fixed very securely to practically unyielding concrete anchorages, it is probable that economies might, in many instances, be effected. On large transmission systems special designs may be justified. The use of massive symmetrical steel towers of the usual type at sharp corners or where lines are "dead-ended" often necessitates an amount of material greatly in excess of what would be necessary in a structure specially designed for the purpose. The guying of steel towers is, of course, only possible when suitable positions for the guy anchors are available.

In concluding this article, the writer wishes once more to emphasize the importance of devoting much time and thought to the various details of overhead line construction before the work is actually started. The proper setting out of the line is among the most important matters connected with overhead construction. If a line is not carefully surveyed and planned in every detail, it will often be impossible to get good and reliable service from it. This does not mean that the commercial aspect of the undertaking is not of prime importance; on the contrary, it is the only aspect from which an engineering undertaking of the kind under consideration should be viewed. But this is not equivalent to saying that a small first cost is always desirable, or that even a short low-voltage transmission line can be constructed and operated economically by persons without engineering skill and experience. At the present time new power developments at the higher voltages, and extensions on a large scale of existing power lines, are generally in the hands of competent engineers and are very thoroughly studied; but this is not always the case with the smaller and lower voltage



"Flexible" Type of Steel Transmission Line Supporting Structure.

undertakings, some of which are not good examples of engineering skill and foresight, and, although perhaps cheaply constructed in the first instance, do not fulfill adequately or economically the purpose for which they were intended.

JAPAN TO ADOPT NEW STANDARDS OF WIRE MANUFACTURE.

According to recent advices from Japan, ten of the principal electric wire manufacturing firms in that country have issued a joint statement advising that they have completed preparations for the production of insulated electric wires and cords to meet the official standards published in October last. The manufacture of the old-type wires and cords which have until this time been used in Japan will be discontinued, it is stated.

WESTERN ELECTRIC OFFERS EDUCATIONAL ADVANTAGES.

The opportunity to pursue part-time post-graduate studies at Columbia University is being offered by the Western Electric Co. to the members of its engineering department. Twelve employes will be selected to study for the degree of Master of Arts. These will be in addition to the other educational advantages which were started by the company at Columbia last fall.

The Stability of Public Utility Investments

Necessity for Communities to Safeguard Interests, Maintain Credit and Insure Stability of Public Utility Companies Emphasized in Address Before Chicago Association of Credit Men

By SAMUEL INSULL
President, Commonwealth Edison Co., Chicago.

The public utility question is always with us—daily, when we get on a street car; monthly, when we get our bills for electrical energy. It is a constant companion, even more frequent than the tax gatherer, and therefore not over-popular with us.

One cannot conceive of the representative of the Internal Revenue Department of the United States Government being over-popular with any of us for the last few years, and I am not sure but what the same attitude of the public exists towards the public utilities. And yet those utilities and their success is an essential part of the development of any community, be it a large metropolitan community like the city of Chicago, or the towns and villages that surround it. The proper development of the utilities has a great deal to do with the orderly and rapid development of city, and, I might say, today, of country life.

We had a great example of a lack of functioning of the greater utilities—the great interstate railroads—at the beginning of the war. Their credit, largely injured by a mistaken public attitude towards them, and largely injured, I think it is only fair to say, by their own acts, was such that it was impossible for them to raise the necessary funds to enable them to function during a period of such great stress as existed during the great war, and as a result it was practically a necessity under which the government acted when it took them over.

Development of Public Utilities Comparatively Recent.

That same state of affairs is quite possible with relation to local utilities. Utilities, as a whole, in the life of our community and of the state, are of comparatively recent development. The gas utility is about the oldest. Water and sewage utilities existed to a limited extent even before the introduction of gas, but of the great utilities of today gas is about the oldest. I think it was in 1849 the first gas utility was established in Chicago.

It is only in relatively recent years that we have had the telephone. The first telephone was shown in Chicago in 1878, and I think the Chicago Telephone Co. was organized in 1881, or a little later.

Electric light is of a later date. The first public street lighting in the state of Illinois, I think, was in Belleville, and about the same time in Springfield, in 1880. It was not until 1885 that electricity was distributed in this state from a central station, and if my recollection serves me correctly it was in the city of Elgin that the first central electric station plant was established. It was as recent as 1888 that the old Chicago Edison Co. started the distribution of electricity in the city of Chicago, and when I came to Chicago in 1892 there was less than a million dollars invested in the business of that company.

It could not have been earlier than 1883 when Mr. Van Depoele made his first exhibition of an electrically driven street car in the city at an exhibition held on the lake front here. So all these things, except gas, are of recent origin.

Investment in Utilities Increasing at Rapid Rate.

The earliest figures we have of total investment in the business are from the census records of 1902. There was invested at that time in electric railways, telephones, electric light and power, and gas utilities about $375,000,000 in the state of Illinois, and the gross income was something under $50,000,000. Taking the figures issued by the census in 1917, and bringing them down to 1920, there is today about $1,250,000,000 invested in these four utilities in the state of Illinois. They have a gross revenue of about $250,000,000.

For every dollar invested it takes five years to turn that investment. That is, if one of these utilities gets a dollar of new business it takes about five dollars of new capital to operate that business. And as a result about $100,000,000 of new capital is required annually in the state of Illinois by the four public utilities referred to.

Most of these utilities are privately owned. I have not referred to the water business, which is very largely publicly owned. There is a comparatively small amount of gas business publicly owned, and a very small amount of electric-light business publicly owned. All street-car service is privately owned, I believe, with the possible exception that the city of Chicago has under certain conditions the right to acquire the street car lines of this city.

A business which has $1,250,000,000 of the money of the people of the state invested; which has 275,000 direct investors in the state, to say nothing of the indirect investors in the shape of those holding life-insurance policies and those having funds in banks, both of which class of institutions are very large owners of public utility securities; a business which requires $100,-

000,000 of new capital yearly, and which has in its service between 100,000 and 125,000 citizens of the state; which has upwards of 1,700,000 customers in the state; which furnishes transportation to practically the whole population of the state at some time in the year or another, and a business whose rate of charge—it matters not whether it is an electric-light company or a gas company or a street-railway company or a telephone company—is mainly dependent upon the price it pays for the money necessary to extend its plant to meet the requirements of the community; a business of that character—and that is the character of the public utility business—is one which is of far greater and far more vital consequence to the citizenship of the state than it is to the so-called owners of the properties themselves.

It is fair to assume that investors in public utilities do not put all their eggs in one basket, and do not confine themselves to this one particular class of investment, and that if they should lose a portion or all of their investment in a particular property it is simply one of those incidents that all who invest money are subject to, and that the failure of any one particular enterprise would in all probability be of less consequence to those who invest their money in it than it would be to the community served by it.

Proper Treatment of Utilities Desirable from Community Standpoint.

Take, for instance, the Peoples Gas Light & Coke Co. That has been the football of politics for so many years in this community that I suppose I can discuss its affairs very freely in public. They have been ventilated so often before council bodies and commissions and other bodies. The stockholders and bondholders of the Peoples Gas Light & Coke Co. have seen their securities go to a minimum price. They have seen their dividends passed. They have seen large losses made; that is, losses from current operation. Supposing that had been carried to a point where the company ceased to function. Would it have been a greater loss to the 12,000 to 15,000 security holders, or to the 700,000 consumers for gas in the city of Chicago?

That is the viewpoint that I especially wish to bring home to you—that this question of the proper treatment of public utilities, of the maintenance of their credit, of the insurance of the stability of their securities, is a question of far greater moment to the community as a whole than it is to the owners of the properties themselves.

We have heard all kinds of talk on the hustings for the last few weeks (for the purpose of catching votes), with relation to traction barons, electric-light barons, gas barons and all other kinds of barons, which is, of course, ridiculous. These properties are not owned by any one individual. They are owned by—take the properties of the state as a whole—about 275,000 different individuals. The Chicago properties, as a whole, are owned probably by 100,000 to 125,000 individuals.

We have heard a good deal of getting blood out of a stone, or milk out of a turnip; namely, getting transportation for less than it is possible for transportation to be produced for. That class of talk does not get us anywhere. It will not enable us to get satisfactory transportation, which this city most urgently needs. It is not possible to continuously get service for less than service costs.

Nobody knows better than you, as credit men and credit women, that an institution which steadily loses money can not possibly be entitled to credit, and unless the public utilities are so regulated that their credit will be improved and built up, it is not possible to raise the necessary money that the transportation demands of a growing city like Chicago requires and demands from year to year.

Investment in Utility Stock of Permanent Character.

There is one aspect of this industry that I think will appeal to you as credit men. I will refer again to the losses of the security holders of the Peoples Gas Light & Coke Co. Those losses are the losses on quoted prices of securities in the public market. They are not losses of actual property, and in these days of commission regulation, when rates are based upon actual valuation of property, and when securities are only allowed to be issued based on the actual expenditures for new property, losses such as I have spoken about are of a mere temporary character. It is very different, indeed, to losses incurred in a business where the capital is more liquid, and where it can be turned over say once, twice or three times or four times a year. It does not matter what may be the position of the utility in the community for the moment. Its property is there just the same. And if its owners have patience to wait until the good common sense of the people demands that that utility should be treated with ordinary fairness, the chances are, if the original investment has been wisely made, that the deterioration in value is but temporary. The property cannot run away. Its investment is of such a permanent character that, if the revenue obtained from it be only sufficient for its proper maintenance, the property is still there. The time comes when the service rendered is paid for on a proper basis, and if the securities have been conservatively issued, the owners are bound eventually to get a return on their money invested.

I think this point is very well illustrated by a remark made to me by the governor of one of the eastern states when we were driving across town a few months ago. He said, "Insull, I wouldn't want to be in your line of business." "Well," I said, "Governor, I wouldn't want to be in your line of business." He said, "Now tell me why." I didn't ask him why he wouldn't want to be in my line of business. "Well," I replied to him, "the property that I have charge of remains here. I remain here. The people in your line of business, Governor, change every few years. And I prefer a permanent to a temporary class of business."

And with all its troubles—and there are a great many troubles, and they have been very serious during the period of high prices—with all its troubles, I think that the public utility business of the state as a whole is in reasonably

satisfactory condition. The securities of the street railways are probably in the poorest condition. They have a much harder problem than have the other utilities. The proportion of labor to gross revenue is very high, indeed, in the street-railway business. The idea of a fixed fare, irrespective of the amount of service rendered, that is, irrespective of the distance you carry a passenger, is a very serious matter for them to deal with.

But take the other local utilities. Take the telephone business,—and we couldn't get along from day to day without it; or the electric light and power, or gas business. I can not recall any important organization engaged in those three businesses that, during the stress of hard times, of high cost, and an unchangeable selling price—except by permission of some regulating body—I can not recall of any one important gas, electric-light or power utility that has gone into the hands of a receiver as the result of the stress of the period of war and the period of high prices following the war.

I want to reiterate, in conclusion, that the question of rates for service is a question of cost of money, and except to the extent that the rate is influenced by the general money rates of the world, the question of the cost of money is a question of credit. You can not expect your public utilities to obtain credit in the money markets of the world, or the money markets of this country—which are practically the money markets of the world today—unless those corporations are so regulated that they can earn enough money to maintain their property and give a return to those who invest their money locally in those properties.

It is to your advantage, it is your duty, if you want to see your community prosper, to see to it that these great agencies, these great servants of the body politic, are allowed to prosper to a reasonable extent. If you do that you establish their credit in the money exchanges of the country. You enable them to get their funds at reasonable prices. You help to maintain the stability of their investments by maintaining their earning power and you confer upon them what in your judgment must be the one first essential to success in any line of business, namely, the necessary credit to justify those who have money to loan to trust them.

EMPIRE STATE GAS AND ELECTRIC ASSOCIATION TO MEET.

The 16th annual convention of the Empire State Gas and Electric Association will meet at Hotel Utica, N. Y., Oct. 7-8. President Horace L. Mann will open the first session with an address, to be followed by committee reports and the following papers: "Selling in a Small Community," by H. K. Stein, superintendent of the Genesee Light & Power Co.; "Importance of Meter Testing," by F. J. Murmann, superintendent of meters for the Westchester Lighting Co.; "Service Charge Rates," by A. Parshall, consulting engineer.

At the afternoon session of the convention, Oct. 7, there will be other papers presented on "Financing Utility Properties," by R. M. Searle, president of the Rochester Gas & Electric Corp.; "The Consumers' Viewpoint," by G. I. Vincent, of the Syracuse Lighting Co., and "The Newspaper Viewpoint," by George M. Smith, managing editor of the *New York Tribune*. At the closing session, Oct. 8, G. N. Snider, coal traffic manager of the New York Central Lines, will review the coal situation, followed by papers on "Office Location, Arrangement and Upkeep," by S. J. Magee, vice-president of the Associate Gas & Electric Co., and "Office Work in a Small Company," by Paul B. Murphy, treasurer of the Potsdam Electric Light & Power Co.

CONTRACTOR-DEALERS ORGANIZE IN WESTCHESTER COUNTY.

As the result of a co-operative meeting of electrical interests at Rye Beach, N. Y., Sept. 24, a temporary organization of electrical contractor-dealers of Westchester county, New York, was effected, with Kenneth C. Ogden, Yonkers, N. Y., as temporary chairman, and I. W. Austin as secretary.

In the gathering were approximately 100 electrical jobbers, manufacturers and central-station representatives. Among the speakers were H. B. Kirkland, of the American Wiremold Co.; W. C. Peet, chairman of the National Association of Electrical Contractors and Dealers; W. L. Goodwin, of the General Electric Co.; M. C. Turpin, of the Westinghouse Electric & Manufacturing Co., and J. P. Ryan, secretary of the New York State Electrical Contractor-Dealers' Association. A permanent organization of the Westchester County Association will be effected at a later meeting.

BOSTON ELECTRICAL CONTRACTOR-DEALERS MEET.

The Boston district of the National Association of Electrical Contractors and Dealers met Sept. 23 at the Boston City Club. The chief speaker was M. C. Turpin, of the Westinghouse Electric & Manufacturing Co., the subject being "Modern Developments in the Industries as Business-Getting Opportunities."

Mr. Turpin illustrated the importance of the electric industry by showing how electricity entered into every phase of modern civilization, mentioning the accomplishment of electricity in aiding humanity by saving coal through the electrification of the steam railroads and battleships; also the entertainment furnished by over 18,000 moving picture establishments to a daily average of 6 to 8 million persons.

ELECTRIC PNEUMATIC BRAKE FOR RAILROAD SERVICE.

The Pennsylvania railroad has been conducting experiments on one of its trains running from Williamsport to Tyrone, Pa., with a new three-wire electric-pneumatic brake and telephone system. The system is said to provide a rapid simultaneous application or direct release of brakes on all cars, regardless of the length of the train, preventing slack action between cars. The telephone system is to keep the members of freight-train crews in touch with each other, but is applicable as well to passenger trains.

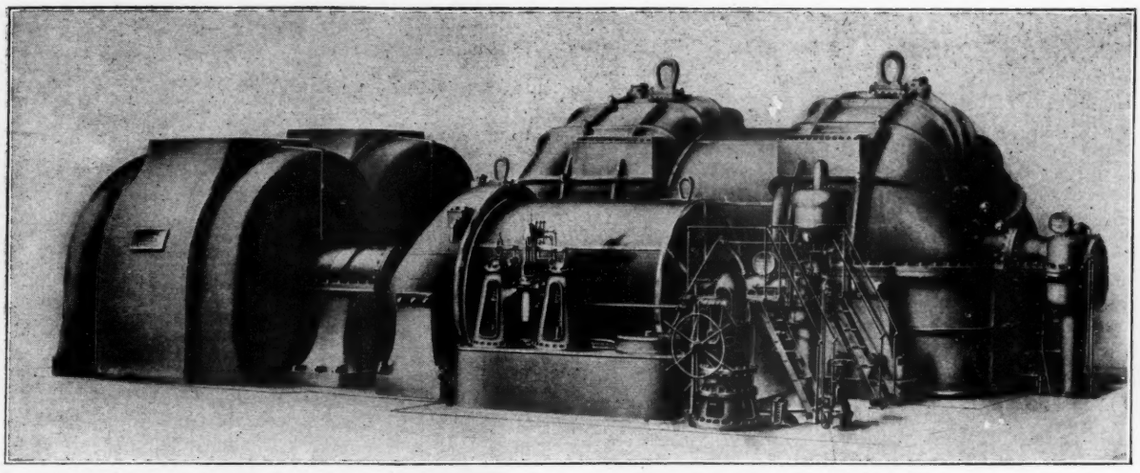


Fig. 1.—30,000-Kw. Alternating-Current Generator with Axial Ventilation.

Construction of Alternating-Current Generators—Part II.

Discussion of Parallel and Radial-Slot Rotor Design and Construction — Stator-Coil Bracing — Collector Rings and Brush-Holders—Turbogenerators for Single-Phase, Unbalanced Loads

By S. L. HENDERSON

Power Engineering Department, Westinghouse Electric & Manufacturing Co.

In the preceding article* on this subject, ventilation of alternating-current generators was discussed, a comparison of the two methods of ventilation being given. This article deals with the construction of rotors with special reference to the subject to slotting.

There are two types of slotted rotors: the parallel slot and the radial slot. The former consists essentially of a solid steel cylindrical forging (into which slots parallel to one another are machined, the coils being subsequently wound into these slots), to which bronze discs are bolted, the discs being in turn bolted to short steel stub-shafts. A better understanding can be had by inspection of Figs. 2 and 3.

The slots are machined to practically the same depth throughout one complete turn, except that at one end axially they must be machined deeper in order to allow for connections; at the corners diagonal cuts are taken to assist in winding and better insure against the breaking of insulation. Circumferential grooves are cut into each end to permit of accurate fits with the bronze discs which are machined to correspond.

The winding consists of flat copper strap which is wound under tension directly from the reel, so that the larger sectional dimension is parallel with the bottom of the slot. No previous forming is required. In the simplicity of winding lies one of the chief advantages of the parallel-slot construction; further, the winding being entirely inclosed practically no dirt can reach it.

The insulation of the parallel-slot rotor between copper and ground consists essentially of mica plate cut to fit in the axial and end portions of the slots, as well as around the corners.

*Published in the Sept. 4 issue of ELECTRICAL REVIEW.

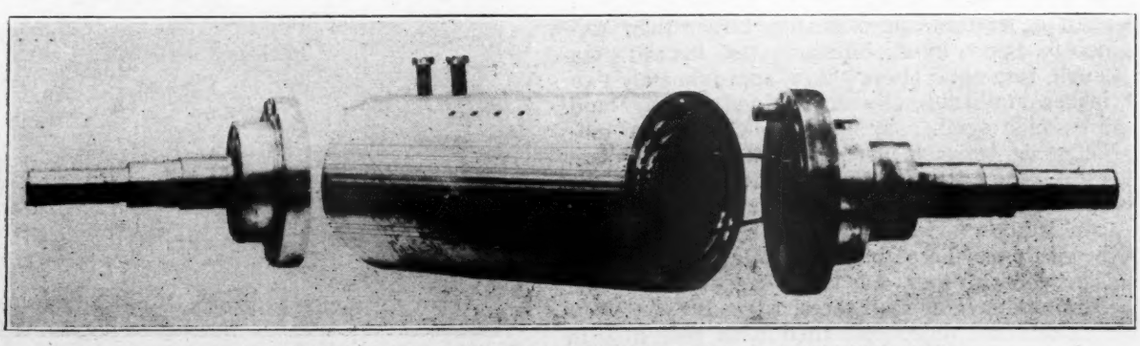


Fig. 2.—Parallel-Slot Rotor, to Which Are Bolted Brass Discs and Steel Stub-Shafts.

The insulation between turns consists of asbestos, which is laid in as the fields are wound. Special corner pieces of asbestos lumber are provided above the coils, in order to fill up the space that is left vacant. After the winding is in place, brass wedges are driven into grooves at the tops of the slots, first at the ends, and then lengthwise. The bronze discs are then bolted to the main body of the rotor.

Radial-Slot Rotors.

Radial-slot rotors are built in two different ways, according to size and speed. In all the smaller machines the principal part of the rotor consists of a solid forging integral with the shaft ends. The forging is machined all over, and radial slots are then cut into it.

For rotors for low peripheral speeds or small diameters the solid forging is entirely satisfactory. In the case of larger machines it is difficult to obtain forged material entirely uniform in its structure. With long, large-diameter forgings the material during the forging process is necessarily worked only in a longitudinal direction and only near the surface. In high-speed turbo rotors uniformity of material is im-

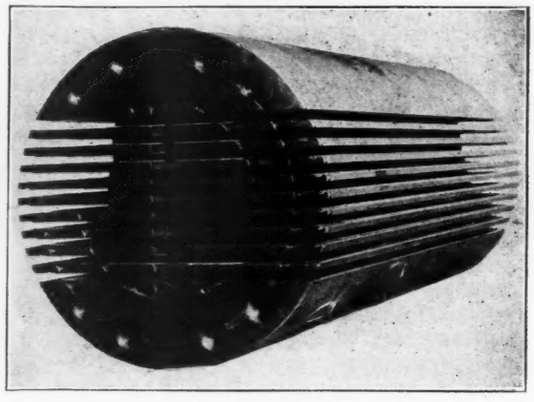


Fig. 3.—Steel Forging Cut With Parallel Slots for Manufacture of Rotor.

portant. A more acceptable grade of steel is therefore employed, found in relatively thin rolled plates. This material is worked in a direction that, in the assembled rotor, becomes radial, and every cubic inch of the material is within an inch or two of a forged surface. Such material has entirely reliable properties from the periphery to the center and from end to end of the motor. It is particularly well adapted for use in large high-speed rotors in which reliability is of first importance.

In generators approximately larger than 12,000 to 15,000 kv-a. plates are used instead of a single forging. These plates, approximately two inches in thickness, are machined all over and are held together by through-bolts and a rabbetted fit between plates. In most of the plate rotors, the greater portions of those parts of the plates into which the slots are subsequently to be cut, are recessed as shown in Fig. 4, the purpose being to provide paths for cooling air to emerge. The ends of the rotor body are made of steel forgings integral with the shaft ends.

The same objections cited with reference to the single-rotor forging do not apply to these

Fig. 4.—Plates Used to Build Up Large Radial-Slot Turbo-generators.

shaft forgings, on account of the much smaller weight of each single-piece forging and on account of the short axial length of the large-diameter part. This short length permits the material to be worked in an endwise or axial direction. While this method of working the material considerably increases the cost of the forging, it insures good properties in a radial direction. The rigidity of the structure is assisted, and the weight of the rotor parts is to a large extent transmitted from end forgings to plates and from plate to plate by means of the rabbet fits (see Figs. 4 and 5).

Holes are machined at regular intervals in the plates and shaft ends, through which heavy special-steel through-bolts are passed, and heavy nuts are screwed on to the ends of the bolts, being pulled up tight enough to insure of initial tension in them. In subsequent machine work the heads of the nuts and bolts are turned off, leaving a sufficient amount of them within the forging to secure ample strength. For all practical purposes this built-up rotor becomes a single piece of very uniform material. Radial slots are then cut into the rotor in either the solid or the plate construction. When the rotor is to be ventilated additional slots are cut below the main slot for winding, as indicated in Fig. 6.

The winding consists of flat copper strap placed so that the larger sectional dimension is parallel with the bottom of the slot. It should be noted that the lengths of the turns are unequal; in any one coil the convolutions are equal in length axially, but circumferentially they dif-

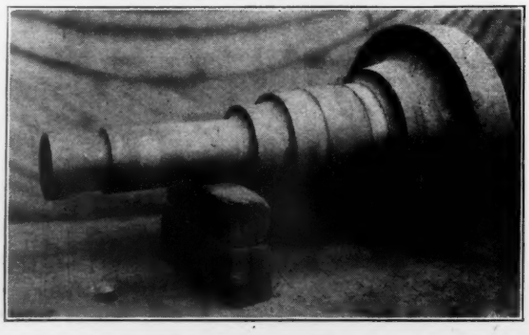


Fig. 5.—End Forging With Plate Rotor.

fer. Formed coils are used and are bent on edge at the corners; the distances between bends must be accurately spaced and the turns must be placed into the slots one at a time.

The insulation between turns consists of mica and asbestos with a very small amount of paper for structural purposes only. The insulation between coils and ground are cells of plate mica. The last turns in the slots are wrapped with mica tape in order to increase creepage surface; then a piece of flat mica plate is placed in each slot over the last turns and within the mica cell. Protection against mechanical injury is afforded by means of a brass strip at the top of the slot, next to the wedge. The ends of the coils are insulated by means of asbestos tape around each individual coil in the larger sizes, and with asbestos tape around a group of coils in the smaller sizes, except where the coils emerge from the slots, and there they are insulated with asbestos tape around the individual coils. . The coils are pulled down into the slots with the use of heavy steel rings, as shown in Fig. 7, and when so clamped the rotor is thoroughly varnished and baked. It will be noted that practically the entire rotor insulation is molded mica or asbestos.

Brass wedges are then driven or fitted into the slots* so as to engage in grooves which had previously been machined in the rotor body. The coil ends are also pulled down accurately to proper dimensions and supported against centrifugal force by means of rings of special alloy steel possessing great strength and ductility. These rings are carefully insulated on the inside by heavy plate mica which is accurately fitted in place. In order to hold these retaining rings in position axially, steel or bronze end plates engage with them and the end plates in turn are held in position by means of nuts which are screwed on the shaft. A rotor built of solid forging is shown in Fig. 8.

Holes are drilled in the end plates, these being for the purpose of admitting air for ventilation. In most of the radial-slot rotors, this air passes into and through the slots cut below the main slots in the rotor and then flows into and is discharged from the various recessed parts in the plates, when plate construction is used, or through circumstantial grooves when the rotor body is solid. In some of the rotors, the main body is not ventilated, and usually, when this condition obtains, air passes through the end windings and is discharged through holes drilled radially in the retaining rings, as shown in Fig. 9. In certain few and special cases, ventilation has been omitted entirely.

*In the smaller radial-slot turbos, the brass wedges are driven in, the pressure on the coil being relieved little by little as the wedge advances. In some large rotors where wide slots are used a three-piece wedge is utilized. This consists of a central part of brass which is held down by means of clamping rings while the two side pieces of steel are driven in. After the latter are in place the pressure secured by means of the clamping rings is relieved. It is believed that this construction results in a more rigid clamping of the coils than is possible with a one-piece wedge.

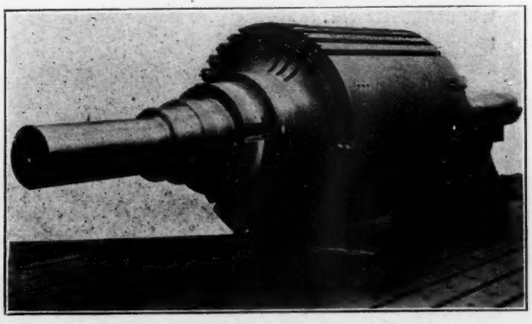


Fig. 6.—Type of Radial-Slot Rotor.

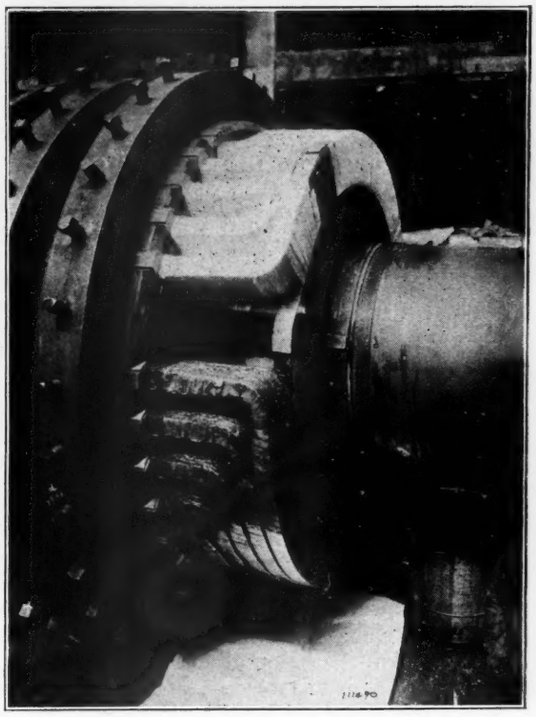


Fig. 7.—View of Rotor Showing Coils Pushed Down into Slots by Heavy Steel Rings.

Stator-Coil Bracing.

Other things being equal, the higher the speed of the machine the lower will be the internal reactance. Therefore, since the angular velocity of the turbogenerator is very high, the reactance is usually low. In case a short-circuit occurs on a system, the current which flows is practically inversely proportioned to the reactance. Although an effort is made, especially in the large sizes, to make the reactance high, nevertheless it is small enough to permit of a great rush of current at the first instant in case of short-circuit. A greater rush of current might ensue, were the alternator connected out of phase in parallel with several other generators than were a short-circuit to occur. In either case, however, the forces which result from the great magnitude of current would produce bad distortion of the end windings of the coils were they not securely braced to withstand such forces. A great deal of attention has been paid by the Westinghouse company to the construction of these coil braces, so as to adequately secure the coil ends.

In the smaller sizes, the coil ends are supported by means of insulated steel rings, to which the individual coils are secured by means of waxed cord. In the larger machines, however, this method of support is not sufficiently substantial. The coils are then flared back at

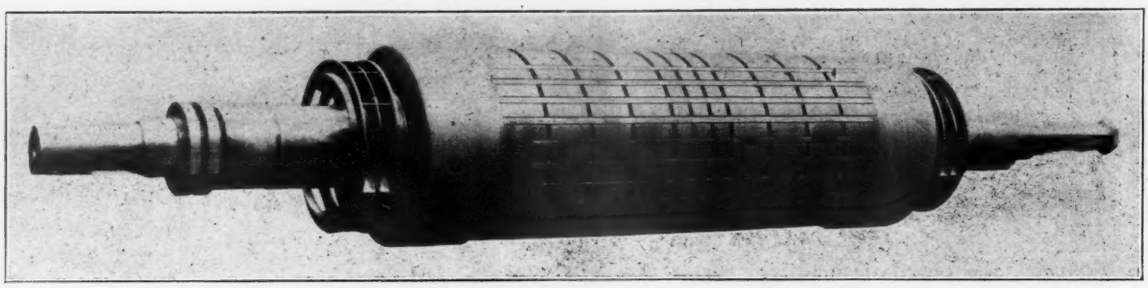


Fig. 8.—Complete Rotor Built of Solid Forging.

an angle of 45 or 60 degrees with an axial line and cast-iron braces are bolted to the frame, so that the inner sides are substantially parallel with the outer sides of the coils. Suitable insulating blocks are then placed between the cast-iron braces and the coil ends. On the inner sides of the coil are placed other flat insulating blocks, and bolts are passed through these blocks, between coils through the outer insulating blocks, and the sides of the cast-iron braces nearest the coil ends. These bolts are suitably insulated from the coil ends. Between adjacent coils, and surrounding the bolts, other insulating blocks are placed to prevent the coil ends crowding (for the same phase). Midway between the cast-iron supporting braces additional braces are used which clamp the coils inside and outside in the same manner, but are not supported by cast-iron members against the frame. In large frames the coils are braced circumferentially where they emerge from the slots by means of insulating blocks, which fit between adjacent coils fairly accurately and are prevented from sliding by cording to the coils, as shown in Fig. 11.

Collector Rings and Brushholders.

Collector rings are made of either cast iron or steel. Cast iron is preferred where the stresses encountered will permit of its use.

There are two general methods of mounting these collector rings on the rotating element. On smaller machines the rings are mounted on a steel bushing which is fitted to the shaft. This bushing is insulated with mica, which is banded on, and the band wires are soldered. After soldering the bushing with its insulation is then turned to an accurate diameter and the collector rings are shrunk on. On larger size machines the collector rings are shrunk over an insulated band on the shaft.

In general, some form of graphite or carbon brush is used for collecting the current from the collector rings. The brushholders are of the radial type and are secured to the end bells in the smaller sizes (see Fig. 12) and to the pedestal in the larger sizes.

Turbogenerators for Single-Phase and Unbalanced Loads.

It is a well-known fact that a balanced polyphase load produces a resultant armature reaction which rotates synchronously, and, consequently, only distorts the main field. With unbalanced load, however, on the polyphase machine, or with single-phase loading, the resultant armature reaction is pulsating. This pulsating magnetomotive force induces currents in the rotor which flow in such directions as to tend to neutralize the magnetomotive force producing them. If these currents have to find their own path in a solid rotor, the losses may become excessive as these currents are of double the stator frequency and will crowd to the outer surface of the iron, giving the effect of high resistance. It is therefore necessary to provide a low-resistance path, or damper winding.

In general, it is necessary to provide dampers in all machines which are to operate with an unbalanced load, and for all single-phase units, except the very smallest sizes.

In parallel-slot rotors the wedges at the tops of the slots, plus additional wedges in those parts of the rotor in which there are no windings, provide sufficient paths for the damper currents in the rotor body. These wedges are then short-circuited by means of the bronze discs at the ends, thus completing the paths for the currents. In radial-slot rotors copper wedges are usually substituted for brass in the main slots, so as to reduce the resistance, and additional copper wedges are placed in those parts of the rotor in which there is no winding. Bronze is substituted for those parts of the retaining rings which engage the rotor body, and these then act as short-circuiting devices for the currents in the wedges. The electrical connection between the wedges and the bronze ring is improved by means of copper straps, mechanically secured to both. In order to damp out the pulsations of flux due to the single-phase currents in the end windings of the stator coils, cage windings at the

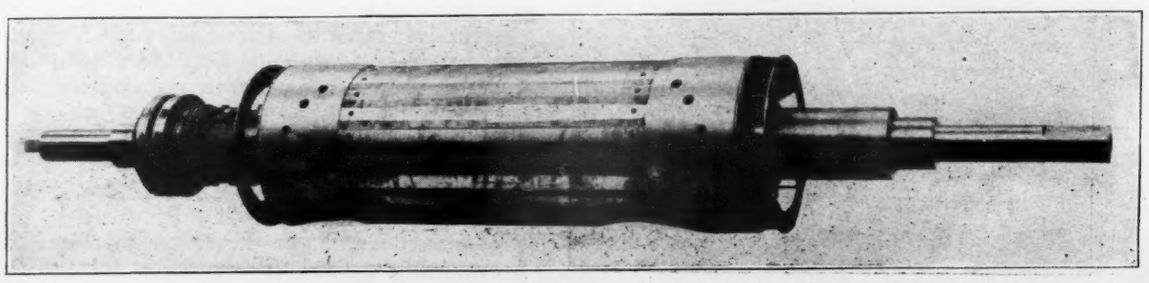


Fig. 9.—Complete Rotor, Showing Method of Discharging Air Through Holes Drilled in Retaining Rings.

outer peripheries of the retaining rings are also provided.

It has been general practice to employ a three-phase star-connected winding in the stator and use two of the three leads for single phase. For the same current per lead, the rating on single phase will then be 0.577 times the three-phase rating.

The single-phase generators, when operating on railway circuits, may have one terminal grounded. In that case there is full-potential strain between those windings connected to the other terminal and ground. This is 1.73 times the insulation strain that would exist were the neutral point grounded in the same machine operating three phase, or in the same machine with uniformly distributed condenser capacity in all phases. This may, in some instances, necessitate greater insulation than would ordinarily be used.

The polyphase generator when supplying unbalanced load has the equivalent of a single-phase load superimposed upon a balanced polyphase load. Therefore double-frequency currents are induced in the rotor in proportion to the magnitude of the single-phase load, and if the unbalancing be more than a small percentage, damper windings should be provided, although in most cases they need not be of so great current-carrying capacity as for a single-phase operation.

Some turbogenerator fields are wound for 125 volts and others for 250 volts excitation. The objection to winding small rotors for 250 volts is that the individual copper straps are quite thin and difficult to handle, and that the percentage of space occupied by insulation becomes a large factor, thereby tending to reduce the output. Furthermore, the cost is increased, due to the difficulty of handling the material.

The objection to winding large rotors for 125 volts is very largely due to the difficulty of handling the large current on the collector rings. Nothing is accomplished by adding brushes, because the increased friction offsets the reduction in brush I^2R loss. To increase the diameter of the rings and thereby increase the heat-dissipating surface (which may or may not be supplemented by addition of brushes) would mean an increase in friction loss due to the higher peripheral speed, and an aggravation of brush chattering. An increase in the width of the brushes is also undesirable because they are now made as wide as is considered good practice for reliable operation.

Up to a total maximum ampere capacity for excitation of 800 amperes it is entirely possible to wind fields for 125 volts. Above this point the risk of collector-ring trouble is considered so great as to render the low excitation voltage most undesirable, even though a partial installation already exists and the change to 250 volts means that an existing 125-volt exciting circuit cannot be used.

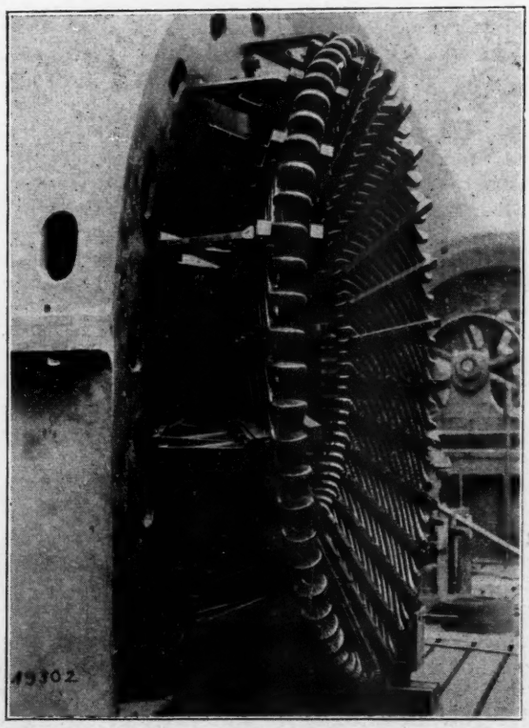


Fig. 10.—Section of Armature, Showing Bracing for 13,200-Volt Winding.

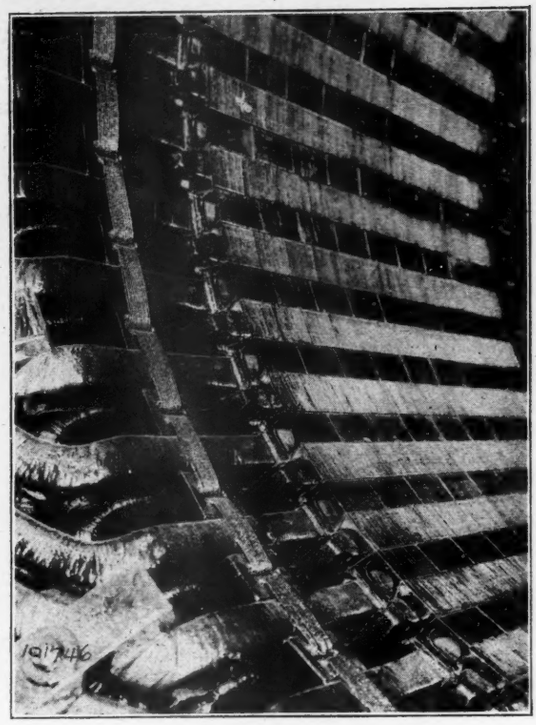


Fig. 11.—Section of Armature, Showing Insulating Blocks Between Coils.

Air Washers.

The air which passes into and through a turbogenerator for cooling the machine is usually laden with dust, and after the machine has been in service for a few months the windings are covered and the smaller ventilating passages more or less filled with a deposit of dirt. The effect is to make more difficult the dissipation of heat from the surfaces where the dirt is deposited, to obstruct the flow of air, and, in some cases, to impair the life of the insulation. The result may be that the machine temperature will be greater after it has been in service for a few months than when new.

Several types of air filters have been proposed

and manufactured, in which the the incoming air passes through some form of cloth screen. The difficulty with this type is that the cloth soon becomes covered with the dirt deposits, and thus seriously impedes the flow of air. To meet this difficulty, air washers have been brought out in which water is sprayed from nozzles into the air before the air passes into the generator. The

Fig. 12.—View Showing Radial-Type Brushholder Construction.

water is so finely divided that practically all the solid matter in the air is deposited with the water on deflector plate in the air washer. Another advantage of the washer lies in the fact that the air temperature is reduced by this process, and therefore the temperature of the machine is also correspondingly lowered. Assuming that other limiting factors permit, the generator capacity is slightly increased by the use of an air washer on account of this reduction in cooling-air temperature. This, however, is the only way in which the air washer does increase the capacity, aside from its primary function of keeping the generator clean. It has sometimes been stated that on account of the greater specific heat of saturated air, as compared with air containing less moisture, saturated air will be more effective in carrying away heat. The difference in specific heat between saturated air (100% humidity) and dry air (0% humidity) is less than 2%, so that while this statement is true the difference is negligible from a practical standpoint. It has been suggested that this effect may be made practically important by supersaturating the cooling air. Experiments have shown that it is impossible to carry free water into a generator with air velocities ordinarily used, and, even were it possible, the wisdom of such practice is, at least, open to question.

The reduction in temperature caused by the change from the natural humidity to 100% humidity will seldom be more than 10 deg. C. No general statement can be made as to the percentage increase in capacity corresponding to this reduction in cooling-air temperature, since the temperature problem is extremely complex, but as a rule not greater than 5 to 10% increase in rating can be expected.

The drop in pressure of the air in passing through an air washer of an approved type is usually small and can generally be neglected. Provided there be a small pressure drop in the air ducts, no further provision for making up for the pressure drop in the air washer need be allowed, whether the generator has internal or external fans.

TURBINE ORDERS INDICATE NATION-WIDE PROGRESS.

Purchases of Generating Units Presages Relief From Power Shortage and Improvement of General Economic Situation.

Orders from electric power companies for over a half million horsepower of turbogenerators have been received by the Westinghouse Electric & Manufacturing Co. within the past three months. This, it is announced, represents the largest volume of power business ever given to a manufacturer by private interests.

These orders undoubtedly form one of the most effective steps that have so far been taken towards the improvement of the general economic situation. The country as a whole is short of power, and, in consequence, industry of every kind has been seriously hampered. The beneficial effects of this substantial addition to power supply will, therefore, be felt by the entire nation, and though the total horsepower involved presents only part of immediate requirements it is sufficiently large to prove a real factor in the restoration of normal conditions.

Among the orders received by the Westinghouse company are the following: Cheswick Power Co., Pittsburgh, Pa., one compound unit of 60,000-kw. capacity, which will be one of the largest machines ever built; Narragansett (R. I.) Electric Light Co., one compound unit of 45,000-kw. capacity; United Electric Light & Power Co., New York, two compound units of 35,000-kw. capacity each; Brooklyn (N. Y.) Edison Co., two single units of 25,000-kw. capacity each; United Electric Co., Springfield, Mass., a single unit of 25,000-kw. capacity; Commonwealth Edison Co., Chicago, one compound unit of 35,000-kw. capacity, and Havana (Cuba) Electric Railway Co., two single units of 25,000-kw. capacity each.

FEATURES OF NEW YORK ELECTRICAL EXPOSITION.

The New York Electrical Exposition will open in the Grand Central Palace Oct. 6 and continue ten days. The number of exhibits arranged for is 141, representing an increase of 48% over the 1919 show. The purpose of the exposition is to demonstrate the varied employment of electricity in the home, office, store and factory, and in each case whole series of displays have been prepared. Of special interest will be the servantless household, wherein electrical machines and devices either perform or greatly lighten the labor of every household task from laundry to nursery. A therapeutic exhibit demonstrating the many and highly beneficial uses of electricity in the doctor's office and hospital will be another feature.

Use of Power-Limiting Reactors for Synchronous Operation

Discussion of Problems Involved—Extensive Employment of Reactors in Generators, Bus Bars, Tie Cables and Feeders Desirable —Paper Before Association of Edison Illuminating Companies

By CHARLES P. STEINMETZ
Consulting Engineer, General Electric Co.

The two foremost requirements of central-station operation, to which everything else must be subordinated, are *economy* and *reliability*.

Economy requires parallel operation of all the generating plant in the system, though divided into a number of large stations located at strategic points of the distribution system, to get the best load-factor, best diversity-factor, and best utilization of the personal element. It also means interconnection of substations by tie lines, to get better loading and reduce the required reserve capacity of feeder cables.

Reliability demands power limitation to avoid the destructive effects of excessive power concentration, time limit of the circuit-breakers and stability of generators and stations in synchronous operation. Power limitation is accomplished by generator reactors, bus-bar or tie reactors and feeder reactors.

Generator power-limiting reactors are used where the true internal self-inductive reactance of the generator is not sufficient to limit the momentary short-circuit current of the generator to reasonably safe values. This is usually the case with 25-cycle steam-turbine alternators, and in 25-cycle systems generator power-limiting reactors are generally used. In 60-cycle machines it is usually possible to give the generator a sufficiently large internal self-inductive reactance without sacrifice of its other constants, so that external generator reactors usually are not needed. The effect of the generator power-limiting reactor is greatest on the initial short-circuit current, less on the transient short-circuit current after a short while, and very little on the final short-circuit current.[1]

Bus-bar or tie reactors are used to limit the possible power transfer between stations or station sections, and thereby to limit any trouble as far as possible to the station or station section in which it occurred, and reduce its severity by limiting the power which the other stations can feed into it, without at the same time interfering with the power transfer between stations, incident to normal operation. The power transfer over the bus-bar reactors occurs by a phase displacement of the station voltages without any voltage drop. In this manner, however, only energy current can be transferred, but not reactive or wattless current.

Feeder reactors are used to isolate cable short-circuits from the bus bars, so that short-circuits in feeder cables near the bus bars do not act as dead short-circuits on the bus bars. Obviously, cable short-circuits are much more frequent than short-circuits on the bus bars. Already a small feeder reactor is very effective in limiting the short-circuit current, since what is a small percentage of reactance referred to the capacity of a feeder is a very large percentage of reactance, referred to the generating station. For instance, with a feeder capacity of 6000 kw. and a station capacity of 72,000 kw., a 3% feeder reactor would be a 36% reactor referred to the capacity of the generating station, and with 12% generator reactance would reduce the momentary short-circuit current from eight times full load of the station to two times full-load current.

Time Limit of Circuit-Breakers.

Either a constant time limit or a time limit depending on the load, and more or less inverse proportional thereto, is used in electrical systems for the following purposes:

(a) In case of trouble, to retain the load while waiting for the trouble to clear itself, so as not to disconnect important loads unnecessarily for momentary troubles which eliminate themselves, but to open only if the trouble persists.

(b) To insure reliable successive operation of a number of circuit-breakers, by interlock, so that the second circuit-breaker does not open until the first one has opened, etc., so that if the first circuit-breaker clears the trouble the second remains closed, and the interference with the system due to opening of circuit-breakers is limited to the smallest extent.

In high-power systems, especially near the source of power, the generator circuit-breakers are given a time limit so they do not open at the initial excessive short-circuit current, but only after the short-circuit current has materially decreased. Even with power-limiting reactors, the momentary short-circuit currents are liable to be so enormous that a circuit-breaker capable of safely opening such currents would be impracticably large and expensive for general use. While in opening short-circuits the time limit is an advantage and even a necessity in protecting the circuit-breaker, it is a disadvantage to the system in exposing it for a longer time to the excessive

[1] Considering, for instance, a typical 25-cycle turbo-alternator with 6% true internal reactance and 100% effective reactance of armature reaction, the following values times the full-load current may be expected:

Short-Circuit Current.	Initial.	After ¼ Sec.	After ½ Sec.	After 1 Sec.	Final.
Without power-limiting generator reactor	16.6	7.5	3.8	1.6	1.3
With 6% power-limiting generator reactor	8.3	5.6	3.8	2.2	1.2

momentary short-circuit stresses, mechanical, thermal and electrical; especially the latter, with regards to synchronous operation, since the liability of losing synchronism between generators, between stations, and between substations and supply, very rapidly increases with increasing duration of the short-circuit.[2]

SYNCHRONIZING POWER.

(1) At zero voltage, such as occurs with a short-circuit at or close to the bus bars, there is no synchronizing power, and generators and station sections during short-circuit thus drift out of synchronism with each other, and then when the short-circuit is cleared short-circuit each other, thus remaining at zero voltage.

(2) The synchronizing power between generators or station sections, that is, the power with which they tend to hold each other in synchronism, is proportional to the square of the voltage, thus decreasing rapidly with the drop of voltage such as occurs by the excessive current of a short-circuit in the system.

(3) Reactance, such as that of power-limiting reactors, may decrease the synchronizing power between alternators or station sections by reducing the current, and thus the power transfer, if the reactance is in the circuit between the alternators or station sections (such as that of the generator power-limiting reactors or bus-bar reactors). Such reactance, however, may also increase the synchronizing power between alternators, etc., especially against sudden or oscillatory disturbances (hunting) by reducing the current and thus the demagnetizing effect of armature reaction, and thereby maintaining a higher induced voltage on the machines, which more than makes up for the lesser interchange current. Theoretically, the optimum value is that when the total self-inductive reactance (internal as well as external) equals half the effective reactance of armature reaction.

(4) Reactance, such as that of power-limiting reactors, may increase the synchronizing power between alternators or station sections by reducing the current and thereby maintaining a higher voltage on the machines, if the reactance is in the circuit between the machines and the source of trouble as short-circuit. Such is the case with a feeder reactance or a bus-bar or tie reactance with regard to the stations in which the trouble does not occur.

(5) Only the quadrature or reactive component of the interchange current between alternators or station sections exerts synchronizing power, but the energy component of the interchange current (due to the resistance of the circuit between the machines or stations) has no synchronizing power. If, therefore, generators or stations are tied together over cables having considerable resistance and little reactance, a tendency to instability may appear, requiring the insertion of additional reactance to give satisfactory parallel operation. Theoretically, at constant voltage at the two alternators or stations, the optimum value is a total reactance equal to $\sqrt{3}$ times the resistance. Usually a materially larger value of reactance gives a greater synchronizing power, due to a lesser drop of voltage.

(6) The speed (or frequency) differences from which turboalternators can pull each other into step are small compared with the speed differences to which generators or stations may drift apart during a short-circuit of very few seconds duration, so that such a short-circuit may result in a permanent loss of synchronism; that is, a drifting of the machines for indefinite time at zero voltage.[3]

(7) The speed (or frequency) differences from which turboalternators can pull each other into step are small compared with the usual difference between no-load and full-load speed, so that if an alternator or station section by a momentary short-circuit drops its load and speeds up to no-load speed it may not catch a synchronism again with the loaded machines or stations, but drift indefinitely out of step, at zero voltage, unless by steam control its speed is brought close to synchronism with the loaded machines.

(8) If the synchronizing power of a machine or station section is greater than its capacity, the machine or station section will remain in synchronism under sudden change of load or speed, such as may occur by the sudden release of load due to the opening of all the substation circuit-breakers, etc. (unless the voltage drops so far that the synchronizing power, which is proportional to the square of the voltage, drops below the machine capacity). If, however, the synchronizing power of the machine or station section is less than its capacity a sudden release of load, etc., may tear the machine or station section out of synchronism with the rest of the system. The same applies with regard to the maintenance or loss of synchronism between synchronous substations and generating stations.

In general, the voltage limit of synchronizing power of individual turboalternators, that is, the voltage below which the synchronizing power drops to less than the machine capacity, is not far from half the rated voltage (usually a little below), and disturbances which do not drop the machine voltage momentarily below half the rated voltage, usually are not liable to throw the machines out of synchronism.[4]

The current capacity of tie cables and the reactance of bus-bar or tie reactors limits the synchronizing power between stations or station sections to less than their rated capacity, especially if accompanied by a voltage drop, and the speeding up consequent to a sudden release of load on one station therefore is liable to break synchronism between this station and the rest of

[2]For instance, in the second case of footnote 1, that is, with 12% total reactance, the relative synchronizing power, that is, the ratio of the power with which the generators hold each other in step to their rated load, is approximately, when a dead short-circuit on the bus bars is cleared after:

	0	¼ Sec.	½ Sec.	1 Sec.	Final.
Relative synchronizing power	4.15	1.86	0.86	0.29	0.09

[3]For instance, with the station constants as given in footnote 1, and different types of machines having different kinetic energy of the moving masses, and thus different rates of drifting apart, it may be, as the result of a short-circuit lasting:

	0	¼ Sec.	½ Sec.	1 Sec.	Indef.
Percent speed difference from which the machines pull into synchronism	1.4	0.94	0.64	0.37	0.20
Percent speed difference by which the machines may have drifted apart	0	1.35	2.70	5.40	....

[4]Some approximate values are given in "Power Control and Stability of Electric Generating Stations," A. I. E. E., June, 1920; General Electric Review, Aug. and Sept., 1920.

the system, unless quickly checked before the critical time has passed.

Conclusions.

In high-power electric generating systems the extensive use of power-limiting reactors is desirable in generators, bus bars or tie cables, and feeders.

Regarding the size of such reactors, the larger the reactance, the less is the shock on the generating station of a feeder short-circuit beyond the reactor; the greater, however, is the size space occupied by, and cost of the reactor, and the larger are the lagging volt-amperes introduced by it into the system. In 25-cycle systems in which the load is mainly synchronous machines, and unity power-factor therefore can always be maintained, this is immaterial. However, in 60-cycle systems having little synchronous load and considerable inductive load, resulting in appreciable lagging current and a power-factor less than unity, the insertion of the feeder reactor tends to lower the power-factor, the larger the reactance.

It thus is desirable to use the smallest size of feeder reactor which gives reasonably safe operation of the system; that is, which in case of a feeder short-circuit keeps the bus-bar voltage of the station above the voltage limit of synchronizing power (about half voltage) and thereby guards against synchronous machines dropping out of step. From this condition, the minimum safe value of feeder reactor can be calculated, in the manner as described in a recent paper.[5]

However, a value of feeder reactance may at full load of the station; that is, with all the machines in operation, in case of a feeder short-circuit, keep the station voltage above the synchronizing limit. But with only a part of the machine capacity connected to the bus bars, the voltage drop with the same short-circuit beyond the same feeder reactor would be larger, and thus may drop the station voltage below the synchronizing limit, thereby throwing the synchronous machines out of step. A larger judgment of the operating engineer is necessary to decide what fraction of connected machine capacity the station voltage should be kept above the synchronizing limit, and the feeder reactor should be calculated to give safe operation with the minimum number of machines which may be connected to the bus bars under important conditions of operation. At periods of very light load the possibility of loss of synchronism usually will be less important, and the possibility of cable failures also less than under full load. Furthermore, at light load the machines probably will not be fully loaded or may be kept at partial load, and then will stay in synchronism down to lower voltage. The voltage limit of synchronizing power is reached when the power which can be transferred between the machine and other machines drops below the load on the machine, and with a sudden release of load the speeding up of the machine cannot be checked any more by the transfer of load to the machine from the other machines. If thus the machine is only half loaded, only half as much power has to be transferred to it to keep it from speeding up out of synchronism at a release of its load. If then the voltage limit of synchronizing power at full load is about half voltage, the voltage limit of synchronizing power at half load would be 0.5 divided by $\sqrt{2}$, or 35% of voltage (the synchronizing power being proportional to the square of voltage).

Furthermore, the drop of voltage under feeder short-circuit depends not only on the value of feeder reactance but also on the duration of the short-circuit, increasing with the duration of the short-circuit. The liability of dropping out of synchronism depends not only on the voltage drop, but also on the duration of the voltage drop; if of short duration a larger voltage drop will be permissible without throwing the machines out of synchronism. Thus, for instance, if by speeding up the circuit-breakers, the duration of the short-circuit could be reduced from 1 to 0.5 sec., the same feeder reactor would give a lesser voltage drop, but a larger voltage drop would be permissible and a smaller feeder reactor would give the same safety of synchronous operation. Thus the time limit of circuit-breaker operation is a factor in the calculation of a feeder reactor.[6]

Bus-Bar or Tie Reactors.

In interconnecting stations (or station sections) by bus-bar or tie reactors, it is preferable to connect the stations in a ring or multiple ring rather than in a chain, since with ring connection serious trouble in one station, leading to this station dropping out of synchronism, would still leave all the other stations connected together in synchronism. If, however, the stations are connected in a chain and an intermediary station drops out of synchronism, this cuts the system in two, as the two ends of the station chain which were interconnected through the disabled station drift out of synchronism with each other. With the disabled station cleared, it then means three groups of stations to synchronize with each other. In ring connection the disabled station as soon as cleared would merely have to be synchronized with the rest of the system, which has remained together. Furthermore, if in case of trouble in a station the reactors which tie this station to the rest of the system are not opened after the clearing of the trouble the station may drop into synchronism again with the rest of the system, if, in ring connection, the rest of the system has stayed together. If, however, in chain connection, the two ends of the chain have drifted apart, the disabled station, when cleared, would try to synchronize with the two adjacent stations, which are out of synchronism with each other, and thus would have to pull these stations into synchronism with each other, which is rather remote. A still more serious trouble with chain connection

[5] "Power Control and Stability of Electric Generating Stations," A. I. E. E., June, 1920; General Electric Review, Aug. and Sept., 1920.

[6] Thus, for instance, with 12% total (internal and external) self-inductive generator reactance, and with a feeder reactance expressed in per cent of the total self-inductive reactance of the generators, not to allow the generator voltage to drop below 60% of the rated station voltage, the circuit-breakers would have to open within 0.32 sec. with no feeder reactance; 0.5 sec. with 50% feeder reactance; 0.75 sec. with 110% feeder reactance; 1.0 sec. with 170% feeder reactance; 1.5 sec. with 260% feeder reactance, and 2.0 sec. with 330% feeder reactance. (330% of the generator reactions of 12% would be a feeder resistance of 39.6%, referred to the capacity of the generating station; thus, with 60,000-kw. generator capacity and 6000-kw. feeder rating, this would give a 3.96% feeder reactor.)

in case of loss of synchronism of an intermediate station is that the two ends of the chain frequently are interconnected through those substations which receive feeders from different generating stations, and tend to synchronize through these substations, and, when drifting apart, short-circuit each other through these substations, resulting in an opening of the circuit-breakers and shutting down of substations outside of the direct range of the trouble, which may involve a large part of the system.

The size of the bus-bar reactors depends somewhat on their method of operation. In case of trouble in one station the bus-bar reactors connecting it with the adjoining stations may be opened instantly or very quickly by automatic circuit-breakers. In this case the affected station is isolated and the rest of the system not affected beyond the momentary shock before the bus-bar circuit-breaker opened. A smaller value of bus-bar reactance may then be used, permitting a much larger current flow over the bus-bar reactors, since this current is interrupted by the bus-bar circuit-breakers before the circuit-breakers in the affected station try to clear it; the current coming over the bus-bar reactors thus does not have to be handled by the circuit-breakers which clear the short-circuit in the affected station. However, this method of operation isolates the station and requires resynchronizing at every trouble leading to a large power transfer over the bus-bar reactors.

A different method of operation is to keep the bus-bar reactors in circuit and the station in which trouble occurs tied by them to the rest of the system. In many cases of trouble in a station the trouble will be cleared before the station has broken synchronism, and at the clearing of the trouble the system immediately resumes normal operation and is not cut in two as in the above case. In this case the circuit-breakers which clear the trouble in the affected station have to open not only the current of the generators of this station but also the current fed into it over the bus-bar reactors, and as large values of bus-bar reactance as permissible are thus desirable to reduce the latter current. The shock on the adjoining stations is reduced by the higher values of the reactance, but its duration is increased. This method of operation seems to have the advantage in all such station troubles which do not involve a loss of synchronism. If, however, the affected station drops out of synchronism and cannot immediately pull back into synchronism at the clearing of the trouble, as soon as this is ascertained (that is, after a minute or two) it should be disconnected from the adjoining stations by opening the circuit-breakers of the bus-bar reactors, and so isolating the affected station and then resynchronizing.

The current capacity of the bus-bar reactor naturally is calculated for the normal conditions of operation, to permit the current of one generator or half of one generator to flow over it continuously without serious heating, and with ample margin to stand the excessive momentary currents flowing over it under abnormal conditions.

Its reactance may be calculated from the same view; that is, to pass the current of one generator or half a generator with a phase displacement of 20 to 30 degrees. This gives an upper limit of reactance, usually larger than desirable from other considerations. In general, the reactance should be high enough to reduce the shock on a station due to a short-circuit in an adjoining station to a moderate value, but still be able to carry a considerable part of the station capacity to keep the station in synchronism at sudden great fluctuations of load, such as due to feeder short-circuits.

The reactance may then be calculated for maximum stability of the stations under sudden oscillatory disturbance. That is, so that the total true reactance of the circuit connecting the two stations over the bus-bar reactor, comprising internal and external generator reactance and bus-bar reactance, equals half the effective reactance of armature reaction of the generators. This generally gives reasonable values and is to be recommended, especially as the curve is very flat; that is, a considerable departure from the optimum value does not much lower the stability. However, the optimum value depends on the number of machines in operation on the busbars, just as discussed under "feeder reactors."

The reactance may also be calculated to give the stations a synchronizing power against each other, sufficient to stay in step under all conditions of load. This gives a lower limit rather and is of lesser value, as in case of trouble the voltage of the station drops and thereby reduces the synchronizing power, and the station may still break out of synchronism. This value usually is too low where the bus-bar reactors are left in circuit in case of trouble, as the power transfer to a short-circuited station is so large as to pull down the adjoining station and not to give sufficient power limitation for the safe operation of circuit-breakers.[7]

In 60-cycle systems having a partially inductive load it must be kept in mind that the transfer of wattless current over to a bus-bar reactor causes a voltage difference between the station sections,

[7] For instance, consider a station section of 80,000 kw. in four machine units of 20,000 kw. each, connected by two power limiting bus-bar or tie reactors in ring with other stations. The rated voltage is 10,000 and thus 5800 volts per phase and 4640 amperes per phase at full station load. Assume 6% internal self-inductive generator reactance. 6% external power-limiting generator reactance, and 100% effective reactance of armature reaction. The total self-inductive station reactance is 12%, or $x_1 = 0.15$ ohm. The total effective reactance of armature reaction is 100% or $x_2 = 1.25$ ohms.

(a) Two bus-bar reactors, each to pass the power of half a generator, or 580 amperes at 30 deg. phase angle:

$$x = \frac{2e \sin \omega}{i} = \frac{2 \times 5800 \times \sin 15}{580} = 5.18 \text{ ohms.}$$

As far as power transfer in normal operation is concerned, this would be the upper limit of bus-bar reactor. It would limit the synchronizing power of the station to

$$P = 2 \times \frac{3e^2}{x} = 36{,}600 \text{ kw.},$$

or 46% of its rating at full voltage, and a quarter of this at half voltage.

(b) Two bus-bar reactors, low enough to give full synchronizing power of the station at half voltage:

$$x = 2 \times \frac{3e^2}{P} = 2 \times 3 \times \frac{2900^2}{80{,}000{,}000} = 0.62 \text{ ohms.}$$

This would be a lower limit of reactor. With a short-circuit in the station the two reactors of 0.62 ohm each per phase would pass a momentary current of

$$i = 2 \times \frac{5800}{0.62} = 18{,}700 \text{ amperes per phase,}$$

or $Q = 3ei = 3 \times 5800 \times 18{,}700 = 325{,}000$ kv-a., which is rather more than desirable unless immediately cut off by instantaneous circuit-breakers.

(c) Two bus-bar reactors, to give maximum stability

and that only a limited amount of wattless current can be transferred (the less the higher the reactance), but that in general each station section must supply its own lagging current.

Generator Reactors.

The generator reactance should be as high as permissible without materially impairing the voltage regulation of the station, as it is most effective in limiting the excessive momentary short-circuit current. The regulation of the generator is determined by the synchronous reactance. This consists of the true self-inductive reactance and the effective reactance of armature reaction. The latter requires time to develop and thus does not come into consideration in limiting the initial short-circuit current. It averages about 100% in steam-turbine alternators. Thus a true self-inductive generator reactance of 10 to 20% appears quite permissible. A 50% self-inductive generator reactance (equal to half the effective reactance of armature reaction) would give maximum synchronous stability, but in general is larger than otherwise desirable.

A further study of the time limit of circuit-breakers is desirable, especially feeder circuit-breakers, with the view of making this time limit as short as the safety of the circuit-breakers permits. Such time limit becomes necessary by the excessive momentary short-circuit currents.

The use of power-limiting reactors, however, greatly reduces the momentary short-circuit current, and the liability of generators and substation apparatus dropping out of synchronism very rapidly increases with increasing duration of short-circuit. However, it must be considered that the power-limiting reactor, while very greatly reducing the initial excessive short-circuit current, may reduce the final short-circuit current very little only, and may even increase the transient short-circuit current after a second or half a second.[8]

The speed or frequency control of high-power generating systems deserves a further study. Loss of synchronism, with the troubles incident thereto and of putting a considerable part of the system out of service for a considerable time, usually is the result of sudden changes of speed due to sudden changes of load during times when by some disturbance the voltage and thus the synchronizing power has been seriously depressed. If therefore independent of their synchronizing power the speed of the individual stations and of the machines in these stations could during troubles be held at the same frequency within the critical slip from which the machines can pull into step; that is, within a fraction of 1%, or could be very quickly restored to the same frequency, the liability of loss of syncronism would be very greatly reduced, and the more so the closer the machines can be held at the same frequency, or the quicker they can be restored.

The more extended use of frequency and phase indicators would therefore appear desirable in the steam control of stations and individual machines in the stations. Such instruments should preferably indicate the frequency difference rather than the frequency of the station; that is, be of the type of synchroscope, but built for remaining continuously in circuit. Such a synchroscope, connected across a bus-bar or tie reactor, would indicate by the rotation of the needle when the two stations are out of synchronism, by the speed of rotation the frequency difference, by the direction of rotation, which of the stations is slower and which faster. It would indicate by a constant deflection of the needle that the stations are in synchronism, but that power is transferred between the stations, and the angle of deflection thus would show the strain on the synchronizing power, 90-deg. phase displacement. It would indicate, by an oscillation of the needle, hunting of the stations and the amplitude of the hunting, and the approach to the oscillatory stability limit, 180-deg. phase displacement. Such phase and frequency indicators, showing in each station the phase difference of all the other stations, would also be of assistance in keeping all the stations in phase with each other and thereby avoiding idle interchange or cross currents between stations through the cables to those substations which receive their power from several generating stations.

The preceding discussions and recommendations are based largely on a theoretical investigation. Due to the complexity of the phenomena involved, extensive approximations and assumptions have to be made, so that until much more extensive theoretical and experimental detail investigations have been made of the various phenomena involved the conclusions and especially the numerical values given in the foregoing, can not claim any very high accuracy, but must be considered as giving the general magnitude of the phenomena rather than their exact values.

The operation of the modern high-powered central station involves, besides engineering, so many other essential considerations of administrative, financial, political, etc., nature which preclude any radical change, so that engineering recommendations regarding installation and operation, if verified by experience, appear to me as outlining a policy in the further development of the system rather than as basis for immediate reconstruction.

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of the station against shocks such as sudden or oscillatory disturbances.

$$x = x_2 - 2x_1 = 0.95 \text{ ohm},$$

or 1.90 ohms per reactor, per phase.

This gives a maximum synchronizing power of the station of 105,000 kw. at full voltage, and a quarter of this at half voltage, which is probably ample. The maximum initial momentary short-circuit current of the station is

$$I_0 = 44{,}800 \text{ amperes, or } 780{,}000 \text{ kv-a.},$$

of which $I'_0 = 6100$ amperes, or 106,000 kv-a., is supplied over the power-limiting bus-bar reactors from the two adjoining stations, thus not giving a very severe shock to these stations.

[8] The reactance, in decreasing the initial short-circuit current, also decreases the rate of its dying out, so that, for instance, after one second the excessive momentary short-circuit current appearing in the absence of a reactance may have practically disappeared, leaving only the small final short-circuit current; while with the reactor, though starting with a much reduced initial value of short-circuit current, after one second a considerable part of this current may still be in existence.

Thus, the initial momentary short-circuit current, the short-circuit current after 1 sec., and the final short-circuit current, with generators of 6% internal self-inductive reactance, 100% effective reactance of armature reaction, and 5 sec. duration of field transient, are, as multiples of rated generator current:

	Initial.	After 1 sec.	Final.
Without external generator or feeder reactance	16.6	1.6	1.3
With 6% external generator but no feeder reactance	8.3	2.2	1.2
With 6% external generator reactance and a feeder reactance equal to total generator reactance	4.2	2.1	1.1
Equal to twice generator reactance	2.8	1.8	1.9
Equal to three times generator reactance.	2.1	1.5	0.9

ORDERS COAL CARS FOR PUBLIC-UTILITY USE.

The Public Service Electric Co., Public Service Terminal, Newark, N. J., has placed an order with the Standard Steel Car Co., Pittsburgh, for 600 all-steel coal cars, each with a capacity of 55 tons, to be used for exclusive company service in transporting coal from the Pennsylvania fields to the local power plants. The cars will furnish about three-fifths of the aggregate supply required, and for the remaining two-fifths supply, the company will depend on the regular allotment of cars under the present priority plan. The contract for cars is given with the approval of the Interstate Commerce Commission.

ELECTRICAL SUPPLY JOBBERS AND REPRESENTATIVES MEET.

Atlantic and Central Divisions of Association Hold Conventions in Philadelphia and Chicago, While Salesmen Assemble in Cleveland.

At the quarterly meeting of the executive committee of the Electrical Supply Jobbers' Association, at Atlantic City, Sept. 21-22, the Duluth Electric Supply Co., Duluth, Minn., and the A. J. Knowlesen Co., Detroit, were elected to membership. A large portion of the time was given to the subject of standing committees. The committee under the new arrangement consists of 11 subcommittees and one general merchandising committee. It will be the duty of each subcommittee in the future to handle such commodities as have close reference to each other. These subcommittees are made up of their chairmen, who are also members of the executive committee, the other committee members being selected from the membership at large.

The executive committee recommended to the association that an appropriation of $6000 be made for the use of the Harvard Bureau of Business Research during the next three years in securing data relating to operating costs and other costs of contractors, jobbers, manufacturers and central-station companies.

At the meeting of the Atlantic Division of the E. S. J. A., Sept. 23, much interest was manifest in the following subjects: "Marsh Patent—Its History, Operation and Effect on the Electrical Heating and Cooking Device Situation," by C. A. Payne, Schenectady, N. Y.; "Advertising Plans of the Publicity Committee for 1920-21," by A. A. Gray, publicity counsel, Chicago; "How Can the Manufacturer Co-operate to Increase the Stock Turnover of His Distributors?" by W. B. Pierce, Eastern sales manager of the Edison Electric Appliance Co., New York City; "Merchandising of Clothes Washing Machines and the Outlook in That Industry," by Raymond Marsh, sales manager of the Syracuse Washing Machine Corp., Syracuse, N. Y.; "The Business Situation From a Financial Standpoint and the Prospects for the Future," by T. H. West, of the Philadelphia Electric Co., Philadelphia.

The quarterly meeting of the Central Division of the E. S. J. A., held in Chicago, Sept. 24, was well attended by jobber members, non-members, manufacturers and others. A. A. Gray, publicity counsel for the association, presented the program mapped out by the publicity committee in a campaign to cover 14 months beginning Sept. 1.

Among the subjects discussed at the Chicago meeting were: "What Can Be Done to Increase the Value of the Association to Its Members," by L. T. Milnor, of the Milnor Electric Co., Cincinnati; "Necessity for Prompt Collections at the Present Time," by W. S. Bissell, of the F. Bissell Co., Toledo, O.; "Motor-Driven Household Devices—What Does It Cost to Market Them?" by F. D. Van Winkle, of the Post-Glover Electric Co., Cincinnati; "The Marsh Patents and the Patent Situation," by C. A. Payne, Schenectady.

ELECTRICAL EXPORTS FOR JULY SHOW INCREASE.

Total Amounts to $6,488,046, an Increase of $491,941 Compared With Same Month Last Year—Seven Months' Figure is $53,214,031.

Exports of electrical goods to foreign countries for July were valued at $6,488,046, compared with $5,996,105 for the corresponding period in 1919, or an increase of $491,941. For the seven months ending July, 1920, the total exports amounted to $53,214,031, or a decrease of $1,389,357 from the 1919 figures and an increase of $19,944,317 over the total for the seven months ending July, 1918.

The following classified figures give the detailed data for July, 1920, compared with the corresponding month last year:

Electrical machinery and appliances (except locomotives):	July, 1919.	July, 1920.
Batteries	$ 379,021	$ 497,657
Carbons	70,991	119,309
Dynamos or generators	475,271	536,400
Fans	142,103	87,892
Heating and cooking apparatus	156,745	124,485
Insulated wire and cables	659,893	558,791
Interior wiring supplies, including fixtures	160,099	336,881
Lamps—		
Arc	835	2,004
Incandescent—		
Carbon filament	4,076	5,303
Metal filament	240,719	244,010
Magnetos, spark plugs, etc.	203,809	304,702
Meters and measuring instruments	125,589	202,612
Motors	546,794	709,086
Rheostats and controllers	26,854	26,283
Switches and accessories	403,748	299,615
Telegraph apparatus, including wireless	44,892	33,150
Telephones	274,387	215,384
Transformers	285,496	165,728
All other	1,794,783	2,018,754
Total electrical machinery, etc.	$5,996,105	$6,488,046

RADIO STATION TO BE ERECTED IN OREGON.

The Federal Telegraph Co. has prepared plans for the erection and equipment of a radio station in Washington county, Oregon, 22 miles west of Portland. The equipment will consist of two motor-generator sets, each comprising a 130-hp., 2300-volt, three-phase synchronous motor, driving a d-c. generator. The two units will operate apparatus of a Poulsen radio system. There will be installed two 15-hp. motors for operating the auxiliary apparatus connected with the radio station. Plans also provide for the erection of steel towers to support the antennae. This station will be on the distributing lines of the North Coast Power Co., Portland.

EDITORIAL COMMENT

Investment of Savings in Public-Utility Properties

In the not so very remote future the spenders and wasters of the present will be in a position to view with more exactness the results of their folly. They will have but little to show for their money which was so freely squandered on abnormal living, luxuries or highly speculative investments. It is now quite evident that the peak of inflation, or high prices, has been reached if not actually passed over. Prices in some commodities are going down, many other prices are wavering, and but few exhibit a tendency to go higher. Labor is more plentiful than for many months, and there is evidence of a restoration of our former influx of immigration.

With these facts in view it is evident that the dollar of the near future will have a greater power to purchase goods than the dollar of today. The dollar saved today will not only earn interest, but will grow in its own intrinsic value. The trying times of the immediate past have somewhat distorted the perspective of many small investors and savers. In fact, many seasoned men of the business world have been badly disturbed by the rapid changes in the apparent values of securities that should be as solid almost as government bonds. But more settled conditions have arrived, and prices and values are returning towards the old standards, although a complete return to old price levels cannot be expected.

Admitting the increasing value of savings, the logical step for the conservative individual is to seek out the most advantageous saving method and apply it to his own particular case. At the present time the securities of public-service corporations offer one of the very best investments for both the small and the large purchaser. The various companies have gone through the most severe conditions imaginable, and the many that have survived have demonstrated the strength and value of the industry which they represent. Market prices of public-service securities are now at comparatively low levels because of the influences of high costs and fixed or limited selling prices of their product. Costs of their raw materials will decline along with other commodities, and the difference between income and expense is bound to increase. In addition to this fact, there is a great unsatisfied demand for increased service, and the assured extensions of service will add to the growing margin of net earnings of the future.

Restoration of normal conditions undoubtedly will divert attention away from the more speculative investments and center the interests of many investors in the more stable and proven enterprises. Such a condition, of itself, would result in material increases in the market prices of many utility securities without the added influence of increasing income and decreasing costs. When all these conditions are considered together, it becomes evident that public-utility investments are not now to be classed as questionable or uncertain, but must be looked upon as safe and most attractive as to future income and stability. The dollar invested, or saved, in good utility properties is assured of its interest return and, in addition, is assured of a healthy growth in its future buying power. With the present favorable purchasing price of securities such investments are assured of an increase of the dollar value of the investment besides the growing value of the individual dollars themselves.

Under such circumstances it is evident that no individual can afford to spend for pleasure, for uncertain investment, or for other questionable purposes, any earnings or savings that can now be placed in good public-service properties. The market is favorable, the range of selection is wide, the future is practically assured, and more advantageous conditions cannot reasonably be expected at some later date. In addition to making a good purchase, the investor is placing his money, if he buys local stocks, in an enterprise that will serve him, improve his community, and add to the comforts and conveniences of himself, his neighbors and friends, and his family after him, for many years to come.

Public Opinion and Electric Service

Public opinion is not formed over night, and when once formed is not to be changed without a certain lapse of time. Public opinion, during the last several months, or for four or five years, has been subjected to many and varied influences. With the coming of more settled times the public mind is ready to receive suggestions that will ultimately result, if well presented, in the formation of new ideas or opinions. The business or enterprise that is alive to the trend of the times will do well to consider this fact and act accord-

ingly. Opinions now formed in the public mind will carry over for many years to come, or possibly until some new great disturbance arises to create another period of abnormal conditions.

The various branches of the electrical industry have been given a large place in the thoughts of the public recently. Campaigns for energy conservation have awakened the public to the fact that the service which they receive depends upon labor markets, upon fuel and material supplies, and upon many other diversified influences, including credit, the money market, and the relative importance of various classes of service. With such ideas coming into the public mind, there opens up a great opportunity for real educational work that will bear immediate fruits and will continue to bear fruits for many years to come. No opportunity should be neglected to advertise electric service in every form to the individual and to groups and organizations of individuals. Every effort should be made to gain the co-operation of every available agency in spreading the truth about the merits of the many services that may be rendered through the agency of electricity.

Already the public utilities of various sections of the country are organizing public-information services, and every state in the country should have an organization for the spreading of true information about the affairs, services and needs of the utility enterprises. The average citizen is willing and anxious to know the truth about the service which he receives, and in most cases he is perfectly willing to pay for what he gets. There can be no harm in telling the truth, but disaster may follow the hiding of it. Practically every central-station company in the country now has all the business they can accommodate, and many have business offered that they cannot take. The public is quick to criticise for failure of service, and whenever a company is carrying loads to or beyond their capacity, the public can be told and will respond to requests for economy, knowing that a little economy will aid in giving service to many others.

Where lack of fuel, lack of help, lack of money or credit, or lack of any other essentials exist, the public may be informed. Using actual conditions that are factors in the rendering of service and presenting them in a fair and open manner to the public, will serve to keep alive the idea that the electrical industry is an agency of service that, aside from giving service, needs the aid and co-operation of its customers. Once getting this point of view, the customer looks with less disfavor on his monthly bill. He also looks with less favor upon political attacks, unreasonable rate demands, and other hindrances thrown in the way of his service. He comes to realize that any burden placed upon his source of service must inevitably be relayed on for him to carry at least in part.

The opportunity for publicity is not confined to central-station companies alone; it is nation-wide, and should be taken advantage of by manufacturers, jobbers, dealers, contractors, and all others interested, each in his own circle of influence. The larger business enterprises can do a double service by aiding the smaller ones and convincing the dealers and contractors that the interests of all are common and that prosperity for all will follow public confidence. Manufacturers and the larger selling organizations should advertise their goods. Advertising fills a definite place in any campaign of publicity that cannot be taken by any other means. It is a definite and concrete demonstration of the advertiser's confidence in his goods and in his belief that the public wants his product. Nothing is more effective in building confidence in a customer than a real exhibition of confidence on the part of the man with goods to sell. The fact that factory capacity may be sold to some future period need not be taken as a reason for hesitancy. The main idea is to keep the electric-service idea before the public in a favorable light for a long enough period to fix the fact in mind that service is essential. And then continue to keep the idea alive by continual repetition of those facts which the public is interested in hearing. With public opinion rightly formed, the many difficulties which have surrounded the industry during the past will be ready for solution, and the legitimate needs for money and for public and private support will be met.

Building Construction Reports Favorable

Statistics of building activities for August in the larger cities of the country, while showing no perceptible gain over the previous month, indicate at least a favorable condition tending toward more active resumption of building construction. The mere fact that there was no further recession during August is cited as encouraging because that month developed intensification of unfavorable influence intended to hamper building. During that month the advance in freight rates resulted in additions to the high prices of materials. The fact that building permits showed no recession, coupled with the knowledge that better transportation conditions may be reasonably expected, leads to the conclusion that the end of this year may see augmented plans for much needed building. Any new building enterprises will have their influences in the electrical industry.

THE WEEK'S NEWS

Reports of Important Meetings, Developments and Other Happenings of the Electrical Industry and Its Allied Interests

CENTRAL-STATION ORGANIZATIONS HOLD JOINT MEETING.

The Rocky Mountain Geographic Division of the National Electric Light Association and the Colorado Electric Light, Power and Railway Association held a joint convention at Glenwood Springs, Colo., Sept. 13 to 15. The two organizations held separate business sessions, matters of general interest to both bodies being discussed at joint meetings. Norman Read, Colorado Power Co., pointed out the lack of understanding by the general public of the problems confronting the utility companies. He suggested that an educational campaign be conducted with the object of encouraging respect for the utilities and the commissions, which will undoubtedly lead to a better public appreciation of the service.

T. O. Kennedy, general superintendent of the Denver Gas & Electric Light Co., spoke on the necessity of uniformity in power contracts throughout the state. He said there seems to be some divergence of practice in charging for extensions and in dividing the costs among the various users of the service. President Martin J. Insull, National Electric Light Association, gave an interesting talk on the work of the parent body and the efforts being put forth for the benefit of the various geographic divisions.

The Colorado Electric Light, Power and Railway Association elected the following officers: President, C. A. Semrad, Boulder; first vice-president, T. O. Kennedy, Denver; second vice-president, F. Norcross, Greeley.

ILLUMINATING ENGINEERS PLAN INSTRUCTIVE CONVENTION.

Minor Changes Improve Program for Annual Meeting, Oct. 4-7, When Leaders in Industry Will Discuss Important Subjects.

Some slight changes have been made in the tentative program of the annual convention of the Illuminating Engineering Society, to be held in Cleveland Oct. 4-7, a draft of which appeared in the Aug. 14 issue of ELECTRICAL REVIEW. It has been decided to hold Tuesday evening's meeting at Nela Park, at which time the paper by O. R. Hogue, J. J. Kirk and E. D. Tillson on "Central-Station Methods for Securing High Lighting Standards in Stores and Homes" will be presented. An opportunity will also be given to visit the factories and laboratories, and to see the home and industrial lighting demonstrations.

The Commercial Section of the National Electric Light Association has arranged to hold its committee meetings in Cleveland during the I. E. S. convention. This will enable delegates to take advantage of both programs. A joint meeting of the Electrical League of Cleveland and the Cleveland Engineering Society will be addressed by Gen. G. H. Harries, president-elect of the I. E. S., at noon, Oct. 7.

Among the papers, addresses and reports not previously announced are: "Progress as Reported in Literature of Illuminating Engineering," by F. E. Cady, chairman of the committee on progress; "I. E. S. Headlighting Specifications—Regulatory and Design," by C. H. Sharp, chairman of the committee on automobile headlighting specifications; "Survey of Voltage Conditions in Automobile," by H. H. Magdsick and Howard Karg; "A Simple Portable Reflectometer of the Absolute Type," by A. H. Taylor, and "Further Statistics on Street Accidents," by Ward Harrison.

Invitations have been extended to, and something of interest is promised engineers, architects, educators, research men, business getters, public officials, photometrists, production and efficiency men and central-station men. All sessions will be held at the Hotel Statler with the exception of the Tuesday evening session at Nela Park.

POWER PROBLEMS DISCUSSED BY IRON AND STEEL ENGINEERS.

Generation, Transmission and Utilization of Electric Power Discussed in Convention at New York City.

Transmission and distribution of power in large quantities and for short distances held the center of attention at the convention of the Association of Iron and Steel Electrical Engineers, held Sept. 20-24, in New York City. Two papers dealt directly with transmission and distribution problems and a third dealt with the related subject of current-limiting reactances. Other papers covered problems relating to auxiliary drives, tonnage, education of electricians, electric furnaces, power-plant design, standardization, development and illumination.

SPECIALIZED EDUCATION RECOMMENDED FOR MILL ELECTRICIANS.

Specialized education, facilitated by specially prepared textbooks, was advocated by the educational committee, of which B. A. Cornwell is chairman. In a paper on "Practical Education of Steel-Mill Electricians to Increase Production," Mr. Cornwell outlined a fairly definite plan for a six-weeks' course of training. The committee is now engaged in preparing a special textbook suitable, in part, for this work. Elementary principles of magnetism and electricity, together with specific and definite discussions of the construction, operation and maintenance of various electrical equipments, are included in this

volume. A recommendation was made that schools be organized in all plants, and that satisfactory class work be given definite consideration at times of promotion of workmen.

Accidents Shown to Be in Direct Relation to Output.

Close observation of accident records reveal that when operating under conditions that give a stated output which does not severely tax the capacity of mills the accident hazard remains practically the same, according to a paper on "Standardization of Electrical Equipment and Its Relation to Accident Hazard," by Walter Greenwood. Increased production, where men and machinery operate at higher or top speed, is always accompanied by increased accident hazards. Standardization for safety, ruggedness, efficiency of equipment and uniformity of arrangement, tends to reduce accident hazards. However, standardization is not entirely desirable where it hinders the development of new and improved equipment. Only by comparison of performance of various types of equipment can actual reliable information be had as to which is best. The most popular demand for standardization is made on account of economy of construction and operation. But equally with these, the demand should be made on account of lowering accident hazard; all are analogous to efficiency in increasing production.

"Transmission and Distribution of Power in Industrial Plants" was the title of a paper by D. M. Petty. Reliability and efficiency were designated as of the greatest importance in a power-distribution system for mill service. Next to these, of course, comes economy. Safety to both life and equipment may be considered as one phase of reliability of performance, since no system can be considered reliable if it interferes with other parts of the plant operation. A system should be so arranged and protected that defective parts will isolate themselves without disturbing other parts of the system. Current-limiting reactors, time relays and other devices may be made to aid in limiting and isolating the effects of the failures that do take place. Flexibility and simplicity of design are great aids in overcoming and correcting the troubles encountered.

General Plan Vital in Design of Distribution Systems.

The physical layout of buses, switches, substations, etc., is of great importance, but more important still is the general transmission and distribution plan. Systems may be laid out on the radial or loop schemes, and each scheme is subject to a number of variations in detail. With either scheme the design should provide for reliable service and isolation of faults. Where a portion of the power supply comes from outside sources, arrangement should be made to carry vital parts of the plant load from either the internal or external source of supply. Overhead systems of distribution are cheaper than underground systems, and are reliable and safe when properly installed and protected. Underground distribution has many advantages when applied through the use of either duct lines or tunnels.

A pressure of 6600 volts was indicated as desirable for steel-mill work. Generators of 15,000-kw. capacity can be built for this voltage, and motors can be operated on it in sizes as small as 250 hp. Use of direct generated voltage on lines and motors eliminates the cost and loss in transformer equipment. The ideal transmission system is that one which transmits the necessary power to the producing department of a plant at the lowest cost, with the least amount of interruption and with the smallest hazard to the lives of all who may be concerned with its operation either skilled workmen or others.

Voltage of 6600 Recommended for Adoption in Steel Mills.

A voltage limit of 6600 or 13,200 was designated as proper and suitable for steel-mill use, in a paper on "Underground Transmission" by A. L. Freret. It was recommended that cable sizes in excess of 500,000 cir mils. should be avoided, and that parallel conductors should be used where greater capacity is needed. Cables insulated with varnished cambric were stated to be best suited to underground work around mills, although paper insulation is cheaper and stands the heating encountered. The chief objection to paper insulation was the possibility of water soaking of joints not sealed in lead sheathing.

Allow Provision for Expansion in Underground Construction.

Manholes 6, 7 and 8 ft. square were recommended as proper to receive duct lines of 4, 6 to 9, and 12 to 16 ducts. An internal diameter of 4 ins. is proper for ducts, and runs should be limited to 12 or 14 ducts wherever possible. Concrete ducts offer high resistance to arcs, and fibre ducts are smooth, easy to install and offer good resistance to arcs of moderate power. A rule followed by Mr. Freret in designing a duct run doubles two more than the required spaces to give the size of line to build to care for possible future needs. The tunnel system has many advantages, allowing for ventilation, increased capacity, accessibility, etc., but is more expensive than other systems.

Considerable mathematics was used in a paper on "Some Considerations Concerning Auxiliary Drives," by Gordon Fox. All manipulating drives are more or less intermittent in their operation, and, consequently, are somewhat different in character from continuous-operating drives. In certain running drives the duty cycle involves running an appreciable time at full speed, the starting and stopping being usually of lesser importance or entirely incidental. A few examples of this type of drive were cited as conveying tables, chain transfers, ingot buggies, slot buggies, etc. Other drives of the "start-stop" type involve relatively short movements in which the greater portion of the operating cycle has to deal with accelerating and retarding the device. Among the more common drives of this type were mentioned the screw-down, side guards, manipulating fingers, etc.

It is desirable in selecting motors to evaluate the various elements of the load as friction, acceleration, etc. The useful work may generally

be calculated quite closely, but for many machines the useful work such as lifting, shearing, etc., may be only a small portion of the duty. The friction load may depend quite largely on the condition of gears, bearings and other parts, but with modern machinery well maintained it is possible to keep the variation within reasonable limits. Frictional loads may be calculated directly, but better results are obtained by estimating from experience with similar equipments.

Adoption of the Ilgner system of drive to reversing mills was given, in the report of the committee on electrical development, as the most important recent development in electrical steel-mill equipment. This committee, of which E. S. Jefferies is chairman, presented a report covering progress during the five-year period just passed. But little if any progress was made in actual installation of electric drives for some time past, but the close of the recent war opened up a great interest in such equipment. A list presented with the report showed a total of 42 reversing-mill equipments now either built or under construction in this country. The list also showed a total of eight plate mills operated by electric power. Three reversing blooming-mill equipments and one rail finishing-mill equipment are being built to replace steam-engine drives.

Motors are being applied to a great variety of small equipment including shears of various types and sizes and to small-size mills. A total of 76 mills using motors of 3000 hp. or less were tabulated. The larger mills mentioned previously have instantaneous capacities up to 22,000 hp.

Large Turbine-Driver Generators Becoming Popular.

The tendency in power-plant construction is towards the installation of large turbine units, concentrating the entire plant capacity in one or two central generating stations. The largest unit now installed is rated at 20,000 kw. Frequencies of 25, 50 and 60 cycles are used in mill practice, but 60 cycles is now believed to be best and 85% of all a-c. equipment built for steel mills is for that frequency. Central-station service was shown to have both advantages and drawbacks, but the facts remain that certain large mills are interconnecting their generating plants with the lines of central-station companies. Developments were noted in the use of synchronous motors, electric welding, transformers, switching apparatus, lightning arresters, electric furnaces, illumination, crane equipment, machine-tool control, etc. Special mention was made of an electrical method of measuring the air supplied to blast furnaces, a measurement previously impossible to make.

Actual records made in two plants were cited by K. A. Pauly in his paper on "The Electric Reversing Mill Considered from the Standpoint of Tonnage." In closing the paper he said, "These records made at the Trumbull plant and at the Sparrows Point works of the Bethlehem Steel Co. exceed those made by any other electrically driven reversing blooming mill and put the electric mill in the class with the steam mill from the standpoint of tonnage. Coupling these records with the advantages of the electric mill over the steam mill from the standpoint of lower power cost, lower maintenance cost, greater flexibility of control, etc., there is little room for argument in favor of the steam reversing mill, and I am convinced that it is now as out of date as the non-reversing steam mill has been for many years."

Important Features of a Steel-Mill Generating Plant.

An estimate of $5,441,000 was given as the cost of steel-mill power plant of 30,000-kw. capacity and having five 40,000 cu. ft. per min. turbo blowers, in a paper entitled "Some Economic Considerations in Design of Power Plants for Steel Mills." The author, T. E. Keating, states that the tendency in design is towards high steam pressure rather than extreme superheats. The plant discussed in the paper was assumed to have four 500-ton furnaces, and mills requiring an average load of 15,000 kw. for 20 hrs. per day for 310 days per year. For four hours per day the load would be 9000 kw., and for the remaining 55 days of the year the load would be 6000 kw. Three 10,000-kw. units, one being for reserve, were designated as proper, and boiler pressure of 250 lbs. per sq. in. was chosen with a superheat of 150 deg. F. Boilers were estimated to operate at 200% of rating, with furnace temperatures of not to exceed 2000 deg. F. and flue gas at 460 deg. F. No economizer is included in the equipment because of low fuel costs and other considerations, the fuel being blast-furnace gas.

In a paper on "Current Limiting Reactances" R. H. Keil discussed the various steps that are being taken in the development and use of this equipment. Attention was called to the fact that a most rugged and liberal design was required. Diagrams and curves were presented to show the various arrangements of reactors and the short-circuit currents under various conditions.

Improvement in Electric Furnaces Still Being Made.

The report of the electric furnace committee, of which E. T. Moore is chairman, dealt with various problems of transformer voltages, automatic control, arrangement of apparatus, use of reactors, electrodes, refractories, etc. While reporting facts indicating great progress in furnace construction, the report calls attention to the fact that there is still room for much research work. Better electrode economy and some kind of automatic charging equipment were considered as important needs of the furnace.

The replies to a questionnaire were tabulated with the report and showed much actual experience with furnace operation. The electrodes in service vary from 8 in. in diameter to 24 in. The average consumption of graphite electrode per ton of product was shown to be 15.3 lbs. The same figure for carbon electrodes was 39.9 lbs.

W. T. Snyder, chairman of the standardization committee, called attention in the committee report to the fact that standardization of crane construction was not making the progress which it should. Such progress will require the finan-

cial support of the various mills and will require concerted effort. The demand for standardized mill-type, d-c. motors calls for uniformity of principle dimensions, uniform speed ratings and a reduction in the number of ratings. The committee notes a growing demand for induction motors wherever their use is possible, but questions their ability to render good service under the trying conditions imposed in steel-mill service. The committee recommended the adoption of the 50-deg. temperature rise as a design rating and a 40-deg. rating for actual use in motorizing machinery in regular steel-mill service.

The report of the sub committee on illumination, of which Ward Harrison is chairman, called attention to the importance of regular and good maintenance and cleaning of lamps, reflectors and other equipment. Regular cleaning, replacement of blackened lamps, use of lamps of correct rating and the refinishing of walls and ceilings at stated intervals was recommended as conductive to good results. A cleaning interval of from 3 to 40 days was recommended, the interval depending on the nature of the location and the quality of cleaning given.

Officers elected for the coming year are as follows: President, E. S. Jefferies, Steel Co. of Canada; 1st vice-president, W. S. Hall, Illinois Steel Co.; 2nd vice-president, C. E. Bedell, Wheeling Steel & Iron Co.; treasurer, James Farrington, La Belle Iron Works, and secretary, John F. Kelly. Gordon Fox, F. E. Galbraith, S. L. Henderson and W. C. Suppler were chosen as the board of directors.

FIRST MEETING OF PACIFIC COAST COMMITTEE, N. E. L. A.

Work of Public Relations Committee Outlined—Appointments Made and Subjects Discussed at San Francisco.

The newly-organized Public Relations Committee, Pacific Coast Geographic Division of the National Electric Light Association, held its first meeting at San Francisco on Sept. 8. The personnel of the committee is as follows: R. H. Ballard, Southern California Edison Co., Los Angeles, chairman; A. Emory Wishon, San Joaquin Light & Power Corp., Fresno, Cal., secretary; W. E. Creed, Pacific Gas & Electric Co., San Francisco; William Baurhyte, Los Angeles Gas & Electric Co., Los Angeles; H. F. Jackson, Great Western Power Co., San Francisco; A. B. West, Southern Sierras Power Co., Denver, Colo.; S. M. Kennedy, Southern California Edison Co., Los Angeles; H. H. Jones, San Diego Consolidated Gas & Electric Co., San Diego, Cal.; Robert Sibley, San Francisco; Glenn D. Smith, Ontario Power Co., Ontario, Cal.; Samuel Kahn, Western States Gas & Electric Co., Stockton, Cal.; Paul McKee, California-Oregon Power Co., San Francisco; S. Waldo Coleman, Coast Counties Gas & Electric Co., Santa Cruz, Cal.; R. S. Wasson, Arizona Power Co., Prescott, Ariz.; H. L. Aller, Pacific Gas & Electric Co., Phoenix, Ariz.; George A. Campbell, Truckee River General Electric Co., Reno, Nev. The ex-officio members are John A. Britton, chairman of the Public Policy Committee, and Lee H. Newbert, president of the Pacific Coast Geographic Division.

Chairman Ballard presented a brief outline of the proposed work for the committee and it was decided that the committee could best function through subcommittees, the following appointments being made: Committee on Public Information, S. M. Kennedy, chairman; Committee on Company Relations with Employes, W. E. Creed, chairman.

The necessity for proper interpretation of the commission's decisions was discussed by Mr. Britton, in order that the action of the commission might receive the proper support and also result in checking spasmodic and unreasonable agitation. It was the unanimous opinion that so far as practicable the employes should be kept informed of development plans and general policy of the company, and given every encouragement to familiarize themselves with the company's operations. Other subjects discussed included inter-company relations, municipal plant accounting and relations with regulatory bodies. It is understood that subcommittees may later be appointed to cover these lines of work.

WESTINGHOUSE TO VOTE ON BIG STOCK INCREASE.

Stockholders Will Consider $50,000,000 Increase in Capital Stock to Permit Additional Volume of Business.

A special stockholders' meeting of the Westinghouse Electric & Manufacturing Co. will be held Nov. 18 to authorize an increase of the indebtedness of the company by $30,000,000 and of the capital stock from $75,000,000 to $125,000,000. The stockholders will also be asked to authorize the issuance of bonds, notes or other obligations, or any of the additional stock of the company in such manner as the board of directors shall deem proper. The need for a substantial increase in working capital to permit the company to carry on its greatly enlarged volume of business is given as the reason for the proposed increases.

In his letter to stockholders announcing the proposed increase, Guy E. Tripp, chairman of the board, says: "The growth of the electrical manufacturing business has been phenomenal. Since 1914 the capacity and output of the company's plants have about doubled, while, by reason of increased costs and prices, the volume of sales has almost quadrupled. The amount of unfilled orders on the company's books at the present time exceeds $95,000,000, an increase of about $24,000,000 in five months. This volume of business, coupled with the increased prices of labor and new materials, requires a substantial increase in the company's capital to enable it to carry enlarged inventories and the increased volume of customers' accounts. Your board does not in this period of high costs contemplate a policy of extensive plant expansion. Your company's current borrowings now approximate $10,000,000. Your board believes that under existing conditions it will be advantageous to provide for all or a large part of this debt by the issue of obligations of a longer maturity.

"It is the opinion of your board that the electrical manufacturing field never presented such possibilities for continued large business as at the present time. The increased cost of fuel and the demand for its conservation will result not only in the development of water powers, but also it is believed in the establishment of large central steam power stations located near the coal fields. The electrification of railroads has been demonstrated as the best solution of the pressing traffic problems in many congested districts and mountain sections, while the demand for the products of your company for use in the marine field is rapidly increasing. There is also a daily broadening use of electricity in the daily life of the people. If your company is to take full advantage of the opportunities thus offered it must add to its permanent capital investment."

In connection with the announcement a statement of earnings for the four months ended July 31 is submitted, which compares as follows with the corresponding period of 1919:

	1920.	1919.
Net operating profit	$4,726,556	$2,019,524
Other income	402,533	473,196
Total income	5,129,089	2,492,720
Interest charges	364,886	558,639
Net income	4,764,203	1,934,081

For the four months ended July 31, 1920, net income after charges and taxes was equal to $3.18 a share on $74,812,450 combined preferred and common stocks, against $1.29 a share for the same period of 1919.

ELECTROCHEMICAL SOCIETY HAS AN ACTIVE MEETING.

Timely Subjects Handled in a Thorough and Interesting Manner at Thirty-Eighth Convention, Held in Cleveland This Week.

The fall meeting of the American Electrochemical Society, held at the Hotel Statler, Cleveland, Sept. 30 to Oct. 2, preliminary announcement of which was made in the ELECTRICAL REVIEW of Sept. 18, presented for discussion 17 instructive papers which had been prepared by able engineers. The subjects and speakers as announced in the tentative program are as follows:

"Heat Losses Through Electrodes of a 6-Ton Heroult Furnace," by M. R. Wolfe and V. deWysocki; "Heat Content of Steel and Slag from an Electric Furnace," by A. M. Kuhlman and A. D. Spillman; "Physical Characteristics of Specialized Refractories. Part III—Electrical Resistivity at High Temperatures," by M. L. Hartmann, A. P. Sullivan and D. E. Allen; "Deterioration of Nickel Resistors," by F. A. J. Fitz Gerald and Grant C. Moyer; "The Söderberg Electrode—First American Installation," by J. W. Richards; "Electric Furnace Smelting of Montana Manganese Ores," by E. S. Bardwell; "Some Phenomena Observed in Electric Furnace Arcs," by J. Kelleher; "Industrial Applications of Electrolytic Conductivity Measurements," by E. A. Keeler; "A New Form of Standard Cell," by C. J. Rodman and Thomas Spooner; "Faraday's Law at the Cathode," by J. W. Richards; "Electro-Deposition of Brass from Cyanide Solutions," by A. L. Ferguson and E. G. Sturdevant; "Tin Plating from Alkaline Tin Baths by Use of Addition Agents," by F. C. Mathers and W. H. Bell; "Electrolytic Refining of Tin," by Edward F. Kern; "Lead Plating from Sodium Hydroxide Lead Baths by Use of Additional Agents," by F. C. Mathers; "Electrolytic Production of Hydrogen Peroxide," by F. W. Skirrow and E. R. Stein; "Influence of Copper, Manganese and Chromium and Some of Their Combinations on the Corrosion of Iron and Steel," by E. A. and L. T. Richardson, and "The Solution of Metals in Acids as Related to Corrosion," by William D. Richardson.

CONTRACTOR-DEALERS PREPARING FOR BALTIMORE MEETING.

Instructive Addresses on Modern Merchandising and Retail Advertising Promised by Rearranged Program for National Convention.

Several additions to the tentative program for the twelfth annual convention of the National Association of Electrical Contractors and Dealers, to be held at the Southern Hotel, Baltimore, Oct. 4-9, have been announced by W. H. Morton, general secretary. The additional addresses promise to add much to the instruction planned for visiting members and others who attend.

On the opening day of the convention W. M. Thompson, Bureau of Advertising, American Newspaper Publishers' Association, will deliver an address on "Advertising for the Electrical Contractor and Dealer." At the same session J. M. Wakeman, general manager, Society for Electrical Development, will speak on the work of that organization. These two speakers will be in addition to an address on "The Industrial Outlook" by a speaker of national prominence, and the routine business. W. Creighton Peet, chairman of the national association, will respond to the address of welcome by Mayor Broening, of Baltimore, and the opening address by C. S. Blumenthal, chairman of the Maryland Association of Electrical Contractors and Dealers.

"What the National Electric Light Association Is Doing to Help the Contractor-Dealer Improve Retail Distribution" will be presented at the Thursday morning session, Oct. 7, by M. H. Aylesworth, executive manager of the N. E. L. A. Other subjects scheduled for this session are: "Sale of Motors for Industrial Use," by J. A. Clark, Westinghouse Electric & Manufacturing Co.; "Successful Conduct of a Contracting Business," by A. S. Abbott, Electrical Construction Co., St. Paul, Minn., and "The Proper Handling of Fixture Sales," by a speaker to be announced later. The afternoon will be devoted to a trip to Annapolis, where the visitors will be addressed by Governor Albert C. Ritchie, and to the United States Naval Academy, where an exhibition drill will be witnessed.

Included in the instructive program for the closing sessions, Oct. 8, are the following speakers and subjects: "A Two-Billion Dollar Industry," by H. B. Kirkland; "Harmonizing the Industry," by Samuel A. Chase; "Scientific Merchandising," by W. L. Goodwin; "Industrial Lighting," by W. G. McKettrick, National Lamp Works of General Electric Co., Cleveland; "A New Era in Lighting," by R. W. Shenton; "See-

ing Is Believing," by Ward Harrison, illuminating engineer, National Lamp Works of General Electric Co.; "Industrial Lighting Market and Contractor's Part in Selling It," by P. B. Zimmerman, manager publicity department, National Lamp Works of General Electric Co. An industrial lighting exhibit will be featured with Ward Harrison's address.

The annual informal dinner will be in the evening of Oct. 8, at which event Judge William H. Wadham, court of general sessions, will speak on "Americanism," and Edward H. Ford, author and humorist, will entertain with "What the World Needs—More Humor." Executive committee meetings will take up the time of the convention on Oct. 4, 5 and 9. There will be the usual provision for entertaining the ladies and for sight-seeing trips.

COMMITTEES OF COMMERCIAL SECTION, N. E. L. A., TO MEET.

The executive committee of the Commercial National Section of the National Electric Light Association will meet in the Hotel Statler, Cleveland, Oct. 8. During the same week the following bureaus and committees of the commercial section will convene at the same hotel: Merchandise sales bureau, Oct. 4; lighting sales bureau, Oct. 4; commercial service and relations with customers committee, Oct. 5; power sales bureau, Oct. 5; compensation of salesmen committee, Oct. 6; education committee, Oct. 6; wiring committee, Oct. 7; advertising and publicity service bureau, Oct. 7; electric vehicle bureau, Oct. 7, and electrical salesman's handbook committee, Oct. 7.

EXPORT CONVENTION TO BE HELD IN NEW YORK OCT. 14.

"To obtain permanent world trade, American manufacturers must themselves take a leading part now" is the keynote of the eleventh annual convention of the American Manufacturers' Export Association, which will meet in a one-day session at the Waldorf-Astoria, New York City, Oct. 14. W. L. Saunders, president of the association, will lead the discussion of world trade opportunities. Eminent authorities on vital business topics will address the convention.

ELECTRIC FURNACE ASSOCIATION TO MEET IN COLUMBUS.

The Electric Furnace Association will hold a meeting in the auditorium of the Home Economics building of the Ohio State University, Columbus, O., Oct. 6. The main subject to be discussed will be "Refractories for the Electric Furnace." The session will commence at two o'clock and will bring together the users of refractories as well as the makers, and a free discussion of the problems of the furnace operator is promised. An excellent program of papers and discussions has been arranged. An invitation has been extended to the delegates to visit the laboratory of the Bureau of Mines Station, where some interesting experimentation with refractories is now being carried on for the benefit of industry generally.

ENGINEERING ADVERTISERS MEET.

"The Management and Organization of an Ideal Advertising Department" was discussed at the Sept. 14 meeting of the Engineering Advertisers' Association of Chicago, at which time G. R. Schaeffer, advertising manager of Marshall Field & Co., told of the efficient department he has in charge. He explained how the various departments and bureaus co-ordinate their work to meet plans approved by the general advertising department.

FALL MEETING OF A. I. E. E. IN PHILADELPHIA.

The first fall meeting of the American Institute of Electrical Engineers, the program of which was given in ELECTRICAL REVIEW of Sept. 18, will be held in the Bellevue-Stratford hotel, Philadelphia, Oct. 8. There will be two sessions, one in the afternoon devoted to the discussion of papers, and an evening session devoted to the centenary anniversary of important early discoveries of Arago, Ampere, Davy and Oersted. The principal speakers at the evening meeting will be Prof. Elihu Thomson and Prof. M. I. Pupin.

COMING CONVENTIONS.

Illuminating Engineering Society. Annual convention, Cleveland, Oct. 4-7. General secretary, Clarence L. Law, 29 West 39th street, New York City.

National Association of Electrical Contractors and Dealers. Annual convention, Baltimore, Md., Oct. 4-9. Headquarters, Southern Hotel. Secretary, W. H. Morton, 110 West 40th street, New York City.

Electric Furnace Association. Meeting at Ohio State University, Columbus, O., Oct. 6. Secretary, C. G. Schluederberg, Box 911, Pittsburgh, Pa.

Empire State Gas and Electric Association. Annual convention, Utica, N. Y., Oct. 7-8. Headquarters, Hotel Utica. Secretary, Charles H. B. Chapin, Grand Central Terminal building, New York City.

Water Power League of America. Annual convention, Washington, D. C., Oct. 7-8. Headquarters, Washington Hotel, Secretary's office, 116 Nassau street, New York City.

American Institute of Electrical Engineers. First regular fall meeting, Philadelphia, Oct. 8. Secretary, F. L. Hutchinson, 33 West 39th street, New York City.

British Columbia Association of Electrical Contractors and Dealers. Annual convention, Vancouver, B. C., Can., Oct. 9.

American Electric Railway Association. Annual convention, Atlantic City, N. J., Oct. 11-15.

National Association of Electrical Inspectors. Annual meeting, Philadelphia, Oct. 12-13. Secretary, W. L. Smith, Concord, Mass.

International Association of Municipal Electricians. Annual convention, New Orleans, La., Oct. 19-22. Secretary, Clarence R. George, Houston, Tex.

Association of Railway Electrical Engineers. Annual convention, Chicago, Oct. 28-30.

National Association of Railway and Utilities Commissioners. Annual convention in the board room of the Interstate Commerce Commission, Washington, D. C., Nov. 9-12.

American Institute of Electrical Engineers. Meeting in Chicago Nov. 12 under auspices of the Protective Devices Committee. Secretary, F. L. Hutchinson, 33 West 39th street, New York City.

Electric Power Club. Fall meeting. Hot Springs, Va., Nov. 15-18. Headquarters, Homestead Hotel, Secretary, C. H. Roth, Adams and Loomis streets, Chicago.

Southeastern Geographic Division of the National Electric Light Association. Annual convention Miami, Fla., Nov. 17-19. Secretary, Charles A. Collier, Atlanta, Ga.

COMMERCIAL PRACTICE

New-Business Methods, Policies, Rates and Kindred Central-Station Matters for the Man Engaged in Selling Electricity

EDUCATIONAL COURSE FOR PUBLIC UTILITY EMPLOYES.

The first course of instructions to employes of the Oklahoma Gas & Electric Co., established to create a better understanding of the company's activities, the functions of the various departments, the technical operations of equipment, etc., came to a close last month. The work has been a great success, as demonstrated by the earnest enthusiasm of those who attended the course and the increased efficiency that has resulted. Owing to the necessity of limiting the size of the classes it was impossible to include all who desired to take the first course, so a second course has been started to accommodate employes who were unable to gain entrance to the initial class.

A POLICY OF COMMON SENSE AND SOUND SENTIMENT.

Empire Gas & Electric Co. Encourages Employes to Become Expert and Thus Render High-Grade Service to Public.

The Empire Gas & Electric Co., Geneva, N. Y., has inaugurated what it terms a policy of common sense and sound sentiment by conferring authority on employes and leaving it largely to them to get results. An individual may call his position in the company service a job, task, position or what he pleases, but every branch of that service has its responsibilities and its possibilities to match. Leadership begins in ability to get the right persons for the places to be filled under direction of the captain whose general policies they are to carry out. The leadership that inspires confidence and wins victories, industrial as well as military, picks its lieutenants and tells them to go to it.

The Empire company states that it is always on the alert to find persons who are capable of assuming responsibility, have the courage of it and are able to reach right results. Such service is not only diligently sought but is also rewarded fairly. Every encouragement to become expert is offered the employe in order that he may render the high grade of service that is provided for the public and at the same time insure permanence of employment for himself. The company is anxious to have employes develop capacity for ever increasing responsibilities, and affords substantial aid to that end for all who want to perfect themselves in their various kinds of service. The gain is mutual. The higher the quality of the staff the higher the quality of the service of the company as a public utility concern.

It is a policy of co-operation that is adopted by the company and followed out with the utmost fidelity and judgment as a scheme of good business and of practical value to workers and not the less excellent if there is a vein of sentiment, of human sympathy and interest, in it. Employes are urged to do their best for their own sake first. The company submits its creed of high ideals and sound business management and invites its employes to do their best to realize those ideals for the sake of citizens, of employer and employes themselves in equal measure.

The company does more than extend an invitation for it not only shows the way, but takes the lead in working for the welfare of consumers and citizens in general with such conditions of work and pay for the employes as to satisfy them of the justice of the company policy and the fairness of its administration. That is why it is ready to confer responsibility where capacity has been shown and to offer chances of advancement to energy, loyalty and ability to get results summed up as good service that wins and holds public good-will.

POWER-FACTOR CORRECTION AND ITS EFFECT.

Method of Charging for Poor Power-Factor—Extract from Paper Before Indiana Electric Light Association.

By Thomas F. English.

All central-station companies are confronted with the problem of increased load and fixed capacity. With the present high prices of equipment and uncertain delivery, it is out of the question in many cases to depend upon additional station and distribution equipment to solve the difficulty. By inducing power users to better their power-factor, the central stations will be able to carry a much greater load than ever before and give better service. Then again, generators can be operated more efficiently, exciters need not be pushed to the maximum and many times machines can be left idle where now they are carrying the watless current.

TABLE SHOWING VARIATION IN POWER LOST IN TRANSMISSIONS WITH VARIATIONS IN POWER-FACTOR.

Power-factor.	Efficiency.	Loss in percent of power delivered.
1.00	88.8	12.75
.95	87.7	14.15
.90	86.4	15.75
.85	85.0	17.65
.80	83.5	19.95
.75	81.5	22.70
.70	79.4	26.00
.65	76.8	30.20
.60	73.8	35.50
.55	70.3	42.20
.50	66.2	51.00

In making up a rate including penalty for low and bonus for high power-factor it has always seemed illogical to base the adjustment on a percentage of the bill. If a customer wastes a cer-

tain number of kw-hrs. due to low power-factor he should pay for that number of kw-hrs., while on the other hand if he has corrective equipment and gives a high power-factor he should be credited with the number of kw-hrs. he saves. With this idea in view a formula has been devised.

The dividing line or neutral point has been designated as 85% power-factor and the efficiency of the line as 85%. Working on this basis, the efficiency of transmission and the loss of delivered power at different power-factors will be as shown in the accompanying table.

With these figures, and understanding that the loss varies inversely as the square of the power-factor, it becomes a simple matter to devise a

TABLE SHOWING MULTIPLYING FACTOR CORRESPONDING TO VARIOUS VALUES OF POWER-FACTOR.

Power-factor.	Multiplying Factor.
1.00	.951
.95	.965
.90	.981
.85	1.00
.80	1.023
.75	1.05
.70	1.0835
.65	1.1255
.60	1.1785
.55	1.2455
.50	1.3335

formula to fit any power-factor. The accompanying table was computed by means of the following formula: Multiplying factor $= 1 - .1765 + (0.1275/\text{Power-factor}^2)$.

This formula gives the factors to be used in multiplying the customer's kw-hr. consumption before applying the rate.

The next question is, how to find the average power-factor. Until recently that was out of

TABLE SHOWING METHOD OF DETERMINING MULTIPLYING FACTOR FROM METER READINGS.

Col. 1. Watless Watts.	Col. 2. Power-factor.	Col. 3. Multiplying factor.
.000	1.00	.951
.143	.99	.954
.203	.98	.956
.251	.97	.959
.484	.90	.981
.512	.89	.984
.540	.88	.988
.567	.87	.992
.593	.86	.996
.620	.85	1.000
.646	.84	1.004
.672	.83	1.009
.698	.82	1.013
.724	.81	1.018
.750	.80	1.023
.777	.79	1.028
1.049	.69	1.092
1.078	.68	1.099
1.108	.67	1.107
1.481	.56	1.230
1.519	.55	1.246
1.559	.54	1.261
1.600	.53	1.277
1.643	.52	1.296
1.686	.51	1.315
1.732	.50	1.334

the question, for when the load was small the power-factor might be lower or higher and still reflect in the average. Now the manufacturers have designed a reactive volt-ampere-hour meter which measures the wattless kv-a. This meter is similar in appearance to the usual watt-hour meters and the dial is read in the same way. The wattmeter measures actual power and the new meter measures the wattless component at right angles to it. Therefore, the reading of the wattless meter divided by the reading of the watt-hour meter gives the tangent of the angle of lag. It only remains to look up the cosine of this angle to get the monthly power-factor. In actual practice a simple table of values can be used, or a curve may be worked up to give the corrective factor direct from the tangent value.

The accompanying table gives corresponding values of wattless meter reading divided by the watt-hour meter reading, the power-factor and the factor by which the watt-hour meter reading should be multiplied.

With a rate of this type it is easy to show the customer that it is to his advantage to install corrective apparatus. In fact, in nearly every case the entire cost of static condenser can be saved within 14 to 18 months, and no sane business man will hesitate to purchase equipment that will save him 60 to 80% of the first cost annually.

Typical Example Worked Out.

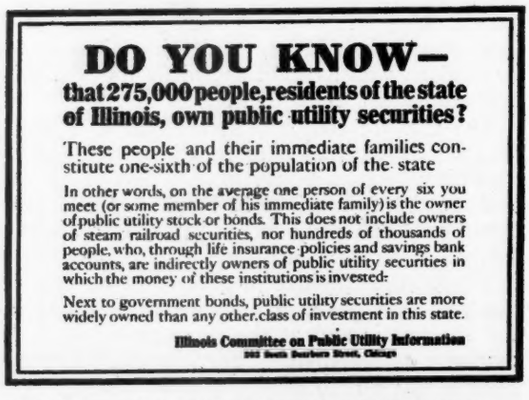
If a case be assumed where the consumption of power for a given month totaled 141,220 kw-hrs., and the wattless meter indicated 154,600 kv-a-hrs. for the same month, the multiplying factor would be found as follows:

Ratio of readings $= 154{,}600/141{,}220 = 1.095$.

Looking down Col. 1, the ratio 1.095 is found to lie between 1.078 and 1.108 in the table. Thus, the power-factor will be between 0.67 and 0.68, and the multiplying factor will be between 1.099 and 1.107. Using the latter figure, the customer's wattmeter reading of 141,220 is multiplied by 1.107 to give 156,331 kw-hrs. as the consumption to be billed for. A more complete table will, of course, give a closer figure for the multiplying factor.

ENCOURAGING PUBLIC TO INVEST IN UTILITY SECURITIES.

With the object of stimulating public interest in the securities of the utilities of the state, the Illinois Committee on Public Utility Information is conducting on behalf of some of the Chicago companies an advertising campaign in the Chi-


DO YOU KNOW—
that 275,000 people, residents of the state of Illinois, own public utility securities?
These people and their immediate families constitute one-sixth of the population of the state
In other words, on the average one person of every six you meet (or some member of his immediate family) is the owner of public utility stock or bonds. This does not include owners of steam railroad securities, nor hundreds of thousands of people, who, through life insurance policies and savings bank accounts, are indirectly owners of public utility securities in which the money of these institutions is invested.
Next to government bonds, public utility securities are more widely owned than any other class of investment in this state.
Illinois Committee on Public Utility Information

Advertisement Used to Stimulate Public Interest in Utility Securities.

cago newspapers and some of the larger mediums in northern Illinois, using quarter and half-page space. A sample of the advertising is presented herewith, which it will be noted calls attention to the large number of people who hold such securities, thereby adding to the necessary fundamental stability of the industry.

OPERATING PRACTICE

Methods and Problems Embracing Operation and Installation of Power-Plant Equipment and the Distribution of Electrical Energy

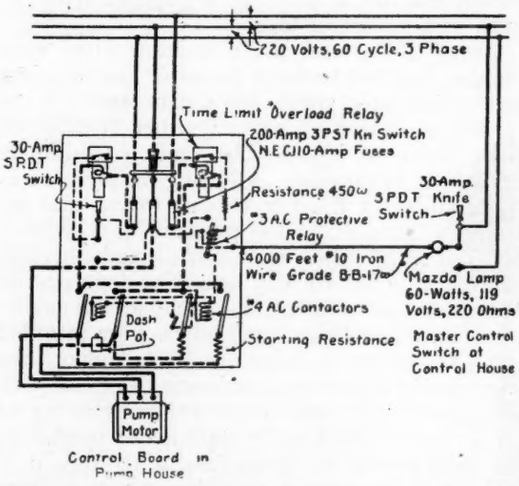
ONE WIRE CONTROLS EQUIPMENT IN PUMPING STATION.

Mtors for Pumping Are Started and Stopped in Control Station or in Pump House by Means of Ingenious Method.

The waterworks department of the city of Fort Atkinson, Wis., operates several small scattered pumping stations, each electrically driven. An attendant at each station has been obviated by using automatically controlled motors, so that one man is able to take care of all the pumping stations instead of one man per station.

The installations are particularly interesting because each is controlled by a single wire; at least two wires are ordinarily employed. The wire is of No. 10 B.B. galvanized iron having a resistance of 17 ohms for the 4000 ft. between pumping station and control house. This wire is supported upon glass telephone insulators carried on the same poles as the 220-volt motor supply circuit.

The wiring diagram shows the scheme of control, by which the pump motor may be started or


220 Volts, 60 Cycle, 3 Phase
Time Limit Overload Relay
200-Amp 3PST Kn Switch
N.E.C.110-Amp Fuses
30-Amp. 3 P.D.T. Knife Switch
30-Amp. 3 P.D.T. Switch
Resistance 450Ω
3 A.C. Protective Relay
4000 Feet #10 Iron Wire Grade B-B-17Ω
Mazda Lamp 60-Watts, 119 Volts, 220 Ohms
3 A.C. Contactors
Dash Pot
Starting Resistance
Master Control Switch at Control House
Pump Motor
Control Board in Pump House

Wiring Diagram Showing How One Wire Controls Pumping Station.

stopped from a distance or started and stopped in the pump house. The pilot light in the control station shows when the motor is running.

TRANSMISSION LINE PLANNED FOR 220,000 VOLT.

For transmitting energy from its new Pit River hydroelectric development, the Pacific Gas and Electric Co., San Francisco, will use 22,000 as the transmission voltage. Energy will be transformed at the station to this voltage by 16,667-kv-a., 127,000-volt, single-phase, water-cooled, outdoor-type, Westinghouse transformers connected in star to obtain 220,000 volts. There will be two banks of three of these transformers making a total rating of 100,000 kv-a. An additional emergency transformer will also be installed to be used on either bank.

SUGGESTIONS FOR EFFICIENT MOTOR OPERATION.

Small Things of Seemingly Little Importance Often Account for the Difference Between Good and Bad Practice.

The improper handling of motor-starting equipment may result in great losses aside from the possible damage of the motor and its connected machinery. Suggestions appearing in a recent bulletin issued by the Tanners' Council, and reproduced herewith, apply directly to this phase of motor management.

"Never remove a fuse from any motor. Transferring a fuse from one motor to another means a delay and a possible burning out of fuse or motor.

"Keep the switch box doors closed. Dust collecting there will eventually give trouble.

"All compensators and switches are plainly marked STARTING, RUNNING and OFF. Look for these signs! Always allow the motor to gain full speed while the handle is in the starting position, then move handle quickly into the running position. The sound or hum of the motor will indicate when full speed has been reached.

"See that the belt is on the loose pulley before stopping the motor, and see that the belt is on the loose pulley before starting up, otherwise there will be fuse trouble. Wherever possible, the load should be entirely removed before an attempt to start up is made.

"If for any reason the current is off in any building or department, the motor starters should be moved into the off position if they have not automatically done so. When the current is again 'on,' the motor can be started without any trouble. Unless this one thing is kept in mind the full line 'current' will be thrown on to a motor standing still, and either the fuse or the motor must burn out. In case a motor fails to start, the quickest and safest thing to do is to call the electrical department. Although it may seem a long time before an electrician appears, this time will not be nearly as long as will be required if the motor is burned out for the want of necessary adjustments or where the wrong size fuse has been substituted.

"Never tighten a belt on a motor—call the millwright. He understands this work better than any one else and he alone should handle it. Tight belts lead up to hot bearings and overheated motors, and overheated motors may cause fires and interruptions to productions."

Several other suggestions are given, the point

made being that care and attention should be given to the handling of the motor and its regulating mechanisms. The losses due to the stopping or breaking down of a motor may greatly exceed the value of the motor itself. One of the suggestions given calls for the testing of each motor as soon as it is installed to determine the actual load which it carries. Such a test may indicate the need of a larger motor, or may show the opportunity of replacement with a smaller one.

OPERATION OF A HOLE-BORING AND POLE SETTING MACHINE.

Machine Bores an Ordinary Hole in Four Minutes and Sets Poles With Crossarms in Place.

The first step in building a transmission line after the layout is completed is the delivery of the poles along the route at the proper distance from each other. Then comes the digging and setting crew who dig the holes and set the poles in the ground. One group of men dig the holes, using long-handled shovels with curved blades, spoons they are called; another group of men follow and pike the poles into place, giving them the proper rake. A gang, working as described above, would have an average speed of one pole set per man day, that is a ten-man gang would set ten poles per day and a nine-man gang would set only nine poles per day. This practice is slow and expensive, but it was the best that could be done until the earth-boring machine was produced and dug in four minutes a hole which the average man would work over for a full day.

The earth boring machine being versatile, picks up the pole, drops it into the hole and moves off, leaving no more to be done except the straightening and raking of the pole and the filling in and tamping of the earth at the butt. Also, the boring machine raises the pole with the crossarms in place, a thing which is not usually done when the pole is piked up.

In moderately soft ground the machine can dig a seven-foot hole and drop a pole in it in four minutes, according to information given in the Detroit Edison *Synchroscope*. This speed cannot be kept up, of course, because of the varying kinds of soil; it is harder to dig through clay than it is through loamy sand, and sometimes there are rocks hidden underground. If the rock is large enough to resist removal successfully, the boring machine is moved over a foot or two and tries a new hole.

The machine used by the Detroit Edison Co. is driven by a gasoline motor and, on a test run, it traveled 1350 ft., dug the holes and set eight poles on only three gallons of fuel. This machine consists of a common type of caterpillar tractor carrying the boring mechanism and a wishbone crane for raising the poles. The boring tool is a larger type of the ordinary fence-post auger. It is mounted on a square shaft which is fed down through the upright framework by sprockets and chains operated with a slipping clutch. When the auger has gone down a foot or more and is loaded with dirt, its rotation is stopped and it is raised to the surface. When it is a couple of feet above the ground it is allowed to spin, throwing the dirt in a neat circular ridge around the opening of the hole. The auger then descends, cuts out another load, brings it up, dumps it, and continues thus until the hole is deep enough to take the pole. The hole being dug, the tractor is moved back a little way, picks up the pole and drops it in the hole.

A truck is used to carry the boring machine from one job to another when the distance is considerable. However, the boring machine has been used to free the truck when mired down on bad roads. The machine can handle any size pole up to 60 ft. high, and works well in wet and swampy ground. The machine, with a crew of eight men, can set 40 poles a day.

LONG SPAN IN HIGH-VOLTAGE TRANSMISSION LINE.

Insulators Subjected to Mechanical Strain of Several Tons and Electrical Stresses of Equal Severity.

The first link in an extensive development of the Knoxville (Tenn.) Power Co. comprises a line approximately 20 miles in length between Cheoate and Alcoa, Tenn. About half of this line is built over rough mountainous country, the construction requiring careful planning and involving the solution of numerous difficult problems. One of the most interesting of these problems, described by Theodore Varney in a paper before the American Institute of Electrical Engineers, was the erection of a 5010-ft. span between two mountain tops.

A total of 83 steel and aluminum wires were stranded together to form the cable for this long span. This cable, which has a diameter of 1.175 ins. and a weight of 2.032 lbs. per ft., has an elastic limit of 65,000 lbs. and an ultimate strength or 82,000 lbs. Allowing an increase in weight of 1.025 lbs. per ft. due to ice, and assuming a horizontal wind pressure of 1.085 lbs. per ft. of length, the total resultant loaded weight per foot amounts to 3.25 lbs. The temperature at the time of stringing the cable was about 80 deg. F., and the three lower spans were installed with a sag of 237 ft. below the lower support, the difference in elevation of supports being 208.5 ft. The upper cable was suspended with a sag of 116 ft. below the lower support, the tension in this cable having a value of about 10 tons.

The insulators used on this long span were made by the Ohio Brass Co. They are rated at 150,000 volts and are of the oil-filled porcelain-covered strain type. The hickory wood used in their construction was carefully selected and tested before being finally passed.

TRANSFORMER OF 3000 KV-A. TO BE INSTALLED OUTDOORS.

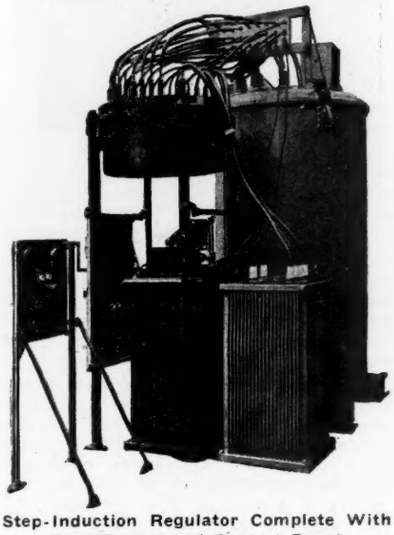
A transformer of 3000 kv-a. capacity is to be installed at Waukegan, Ill., on the lines of the Public Service Co. of Northern Illinois. This transformer, which will be located in the yard just outside the generating station, will be used to feed a 33,000-volt transmission line to Crystal Lake, Ill. The line between these two locations operated formerly at 20,000 volts.

NEW APPLIANCES

Newly Developed and Improved Electrical and Mechanical Apparatus, Appliances, and Devices Now Being Placed on the Market

Step-Induction Regulator for Furnace Control.

For controlling the energy input to carborundum, graphite, aluminum, zinc and similar types of electrical furnaces,

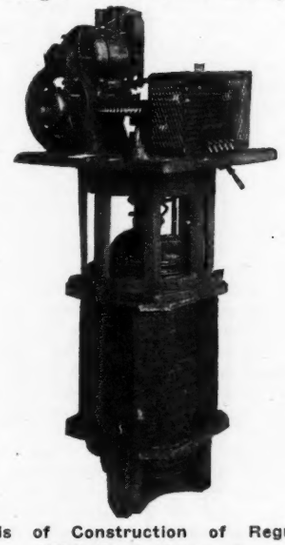


Step-Induction Regulator Complete With Transformer and Control Panel.

the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., is manufacturing a step-induction regulator which gives a uniform voltage over a wide range. The regulator consists of a furnace transformer, an induction regulator, switches and push-button control. This apparatus utilizes the principle of varying the high-voltage tap on the transformer for controlling the energy input to the furnace. The function of the induction regulator is to vary the voltage between taps. After the voltage of the adjacent tap is reached, the selector and transfer switches automatically transfer the induction regulator so that it will function between the next two taps. One of the main features of this apparatus is that the entire voltage range is controlled by two push buttons, one for boosting and one for bucking the voltage.

On the shaft of the regulator is geared a selector switch, the points on this switch being connected directly to taps on the high-voltage winding of the furnace transformer. The selector switch-arm moves from one contact to the next automatically as the induction regulator moves. The function of the feeder-voltage regulator is to add to, or subtract from, the normal voltage of a transformer tap, and is designed so that at the position of maximum boost it will add exactly one-half of the voltage between adjacent transformer taps. At the position of maximum buck the regulator will subtract exactly one-half the voltage between adjacent transformer taps. Considering a single position of the selector switch-arm, a single rotation of the moving coil of the induction regulator will vary the voltage impressed on the high-tension winding from a position one-half step below to a position one-half step above the voltage point actually represented by the transformer tap. The selector switch-arm is moved from one tap to the next just as the voltage half way between adjacent taps is reached, so that continued rotation of the regulator coil produces a continuous variation raising or lowering the voltage in accordance with the direction in which the regulator coil is being turned.

While the above is the fundamental operation of the apparatus, in actual practice there are slight modifications. The moving coil of the regulator makes but one-half a revolution to go from the position of maximum buck to the position of maximum boost, at which point the selector switch moves to the next higher voltage tap, and the regulator must be brought at the point of maximum buck before it can, by continued operation, raise the voltage over another step. That is, at this point, the direction of current through the regulator coil must be reversed. Actually, the result is obtained by a second coil of opposite polarity which is cut in at the proper time by a transfer switch, and the regulator changes directly from maximum boost to maximum buck so that continued rotation still acts to raise the voltage. The two-coil arrangement



Details of Construction of Regulator With Tank Removed.

also makes desirable two-selector switches geared together for continued voltage variation. With high incoming line voltage a series transformer is interposed between the high-tension line and the induction regulator. This allows the use of a less bulky low-voltage induction regulator, and insures against trouble with insulating moving parts for high potentials. In this case two coils are incorporated with the series transformer instead of in the regulator itself, thus accomplishing the same current reversing purposes. The operation

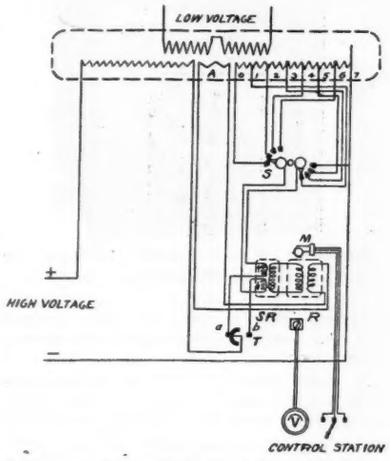


Diagram of Connections of Step-Induction Regulator.

of this regulator may be seen by reference to the schematic diagram.

Three-Phase Receptacle With a Spring Door.

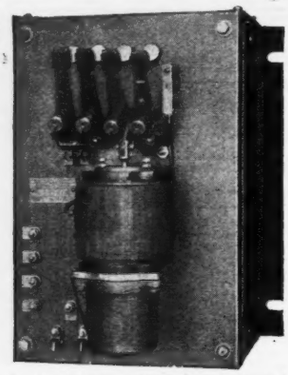
A receptacle for three-phase circuits having an extension with a spring-door cover has been developed by the Central Electric Co., 320 South Wells street, Chicago. The extension is so constructed that it can be mounted on the receptacle in four positions so that the door can be opened to either side, to top or bottom, as desired. The dimensions of this receptacle when closed are 7 in. high, 4.75 in. wide, 4.75 in. deep. This "Ralco" No. 610 receptacle is identical in construction to the old No. 10, except that it has the extension.

Motor Starter With Time-Limit Acceleration.

The time-limit automatic motor starters made by the Cutler-Hammer Manufacturing Co., Milwaukee, have been redesigned and the line has been enlarged to include both larger and smaller units than formerly. The air dash pot has been replaced by an oil dash pot, with the former optional on the new equipment. The solenoid, plunger and rocker arm have been retained.

The new starter is made in capacities of from 0.25 to 10 hp. at 115 volts, and up to 25 hp. at 230 and 500 volts. The 500-volt sizes are more compact than formerly. The oil dash pot is completely covered so as to be splash proof, and is adjustable for time by an external screw. When this screw is once set, the starter will always cut out the resistor in the same length of time. A non-freezing dash-pot oil is used so that temperature conditions will not affect

the length of time for starting. The fingers on the rocker arm are of the makers standard drum construction and, like the contact buttons, are renewable. This starter can be controlled from any remote point by a single-pole knife or snap switch, pressure or vacuum regulator, float, switch, or by three-wire push-button control. Low-voltage release is inherent with two-wire control and low-voltage protection with three-wire.

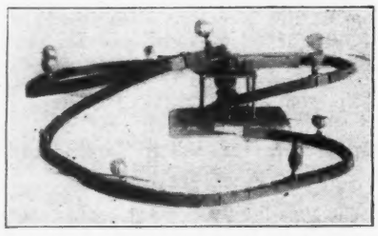


Time-Limit Motor Starter Suitable for Accurate Setting.

A slate panel carried on a pressed-steel wall frame is used for mounting the starter, with the starting resistance self-contained. A starter of this type (time-limit acceleration) is particularly adapted for starting d-c motors carrying loads which are liable to vary between wide limits, and where remote control is desired for such equipment as pumps, blowers, compressors, etc.

Toy, Advertising Novelty and Window Display.

It is a well-known fact that light and a movable object will always attract attention, especially if the movable objects can be so arranged that they will move in an out of the ordinary way and also if there is more than one object to observe. The combining of these features in such a manner that the device can be used in many fields of commercial enterprise was undertaken by Edward A. Dieterich, 910 Caldwell avenue, New York City, in the production of the device shown in the accompanying illustration. By placing those particular objects which are to be advertised in transparent miniature form over the lighted bulbs, and making them travel in any position that the guideway has been placed, hung, or suspended to suit the conditions, accomplishes the objects of illumination, motion and change of object.



Moving Illuminated Display Device.

When advertising is to be carried on in an automobile supply store, a tire, can of oil, spark plug, etc., is placed over the lighted bulbs, in miniature form and of a transparent material; in a grocery store a can of peas, box of biscuits, etc., may be used. As a toy the device may be used on a Christmas tree, with birds and other objects of that character placed over the lighted bulbs and made to travel in and around the tree. The device can also be used as a scenic-railway, roller-coaster, loop-the-loop, etc.

The whole operation is accomplished in a simple manner by means of a suitable flexible slotted housing or guideway, a suitable flexible shaft which carries the various objects, and the electrical conductor.

Synchronous Motor Used for Frequency Control.

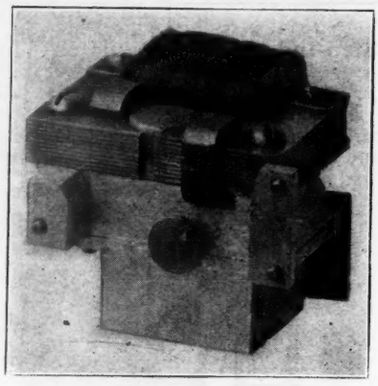
The latest departure in synchronous-motor application is the installation of a very small self-starting motor in a clock, where it is used in connection with a high-grade clock movement to compare the speed of a synchronous generator with exact time in order to give a continuous check on generator frequency. Since any change in the speed of the generator is reflected in the speed of this small motor, whereas the clock speed remains constant, the combination forms an accurate method of maintaining constant average frequency.

These small motors can also be used on the system in place of clock mechanisms to drive graphic recording instruments, demand meters and time switches. By the use of this motor the synchronization of records from graphic meters and demand meters will be made possible; something that has always been desirable, but somewhat difficult of accomplishment heretofore.

In practice, a master clock containing two movements, one electrical and one pendulum-operated, is located near the switchboard. The face is equipped with two pointers, one black and the other gold, rotating independently about the same center on a dial called the operating dial. The black pointer is so geared to the pendulum clock as to make one complete revolution every five minutes. The gold pointer is geared to the small synchronous motor so that when the frequency is correct it will rotate at the same speed as the black hand. All that the operator has to do is to hold the two pointers together in order to have a fixed relation maintained between standard time and generator speed, or between cycles and time. This can be done by adjusting the speed governors of the prime movers. The master clock does not obviate the use of a frequency meter or indicator, since it will not show instantaneous fluctuations in speed. Moreover, by using a frequency indicator near the master clock, the latter may be used as a constant check on the accuracy of the former.

The little synchronous motor, which is the vital part of the electric component of the clock, is only 2⅛ in. by 2⅝ in. by 2 9/16 in. in size, and is wound for operation on a 110-volt circuit. It consumes less than 4 watts, and can be made for any one of the standard commercial frequencies. It is self-starting under load, reaches synchronous speed in less than a second and holds speed as long as the current is uninterrupted. It is simple in construction, and, since its gearing runs permanently immersed in oil, it requires but little attention to keep it functioning properly.

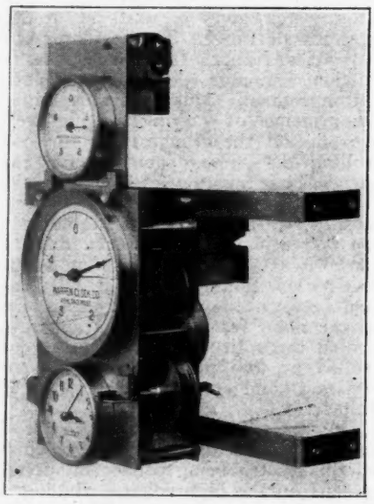
There have been developed two forms of master clock known as the type "A" and type "B." The principal difference in operation of these two clocks is that in the "B" type both the motor and the clock mechanism act on the same index hand through gearing so arranged that the synchronous motor tends to drive the hand in one direction while the clock mechanism tends to drive it in the opposite direction.



Motor for Master Clock.

If the rate of the clock and motor are the same the hand rests at zero on the scale, but if the speed of the motor varies the hand is moved slowly in a clockwise or counter clockwise direction, according to whether the variation is a gain or loss in speed. In this way the clock is caused to indicate variations in average frequency.

The installation of these master clocks will not eliminate fluctuations which are dependent to some degree on load variations, speed-governor response, or steam pressure, features of operations that are more or less constantly encountered. But it does insure the maintenance of a more uniform as well as correct average frequency.



Dials and Mechanism of the Master Clock.

The clocks and motors are manufactured by the Warren Clock Co., Ashland, Mass., and are being handled by the General Electric Co., Schenectady, N. Y.

ACTIVITIES IN THE TRADE

Business Developments, Sales Agencies, Trade Literature and Miscellaneous Items Concerning Electrical Manufacturers and Allied Business Interests

Anderson Electric Co., Detroit, plans to erect a factory at that place.

Lyons Storage Battery Co., Philadelphia, has increased its capital stock from $500,000 to $3,200,000.

National Brake & Electric Co., Milwaukee, is erecting a two-story addition, 166 by 180 ft., at an estimated cost of $150,000.

National Lamp Works of General Electric Co., Cleveland, plans to erect three-story plant on Alonzo avenue, at an estimated cost of $300,000.

Arrow Electric Co., 99 Hawthorne street, Hartford, Conn., is planning extensions and improvements in its three-story plant on Capitol avenue.

Electric Storage Battery Co., Philadelphia, plans to erect a two-story station, 120 by 200 ft., at 222-232 East 55th street, New York City, to cost about $100,000.

Falkenbach Manufacturing Co., 159 East 54th street, New York City, manufacturer of lighting fixtures, has increased its capital from $30,000 to $100,000 for expansion.

Benjamin Electric Manufacturing Co., Chicago, is sending to the trade revised price lists on its line of copper-cap porcelain sockets, and also on pendent and wall porcelain sockets.

American Steel & Wire Co., Worcester, Mass., has commenced the erection of a two-story building at its local plant, known as the Central Works, 48 by 90 ft. with one-story extension, 18 by 18 ft.

Duplex Storage Battery Co., 537 Edison avenue, Milwaukee, has purchased a factory at Beaver Dam, Wis., where its plant will be located. A reorganization from a $60,000 to a $500,000 corporation is now taking place.

Exide Battery Depots, Inc., 101 West End avenue, New York City, operated by the Electric Storage Battery Co., has completed plans for the erection of a new two-story battery service station, 115 by 125 ft., at Clark and Spring streets, to cost about $117,000.

Peerless Insulated Wire & Cable Co., Pennington, N. J., manufacturer of electrical wires, etc., is having plans prepared for extensions and improvements in its plant to cost about $50,000. Water Kidde & Co., 140 Cedar street, New York City, is the contractor.

General Electric Co., Schenectady, N. Y., will exhibit electric rivet heaters, glue pots and soldering irons, electric muffle type furnace, self-regulating solder melting pot, tool-room heat-treating muffle furnace, cartridge units, helical coil units and immersion units at the New York Electrical Show, Oct. 6 to 16. Ovens heated by "G-E" electric heating units will also be shown.

Electric Furnace Construction Co., 908 Chestnut street, Philadelphia, advises that its first electrically heated core and mold-drying oven has been put in operation at the plant of the Emery Steel Castings Co., Baltimore.

Sterling Manufacturing Co., Cleveland, manufacturer of ammeters and voltmeters for generator outfits and for testing dry and storage batteries, has moved into its new plant at 2845-2853 Prospect avenue, which covers 20,000 sq. ft. of floor space.

Dwight P. Robinson & Co., 125 East 46th street, New York City, has opened a branch office in the Home Savings and Loan building, Youngstown, O., under the management of C. I. Crippen, formerly a consulting and supervising engineer in that city.

Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., has acquired a tract of property aggregating about 5.5 acres of land at East Wilkinsburg, Wilkins township, for a consideration of $10,000. No announcement has yet been made as to proposed use of the property.

Hobart Brothers Co., Troy, O., manufacturer of "HB" battery-charging equipment, electric motors and lighting generators, has added ball-bearing electric motors to its present line of electrical specialties. The new line will consist of 1, 2, 3, 5, 7.5 and 10-hp. motors for both alternating and direct current.

Roller-Smith Co., 233 Broadway, New York City, manufacturer of electrical instruments, meters and circuit-breakers, has issued bulletin 800 on types FID and SD direct current volt-ammeters for use with battery charging outfits, small and large lighting plants and for other similar applications, also bulletin 450 on alternating current switchboard instruments, and Bulletin 430 on direct current switchboard instruments.

Willis H. Gilbert Co. has established a yard and office at Bainbridge, Ga., for the handling of southern white cedar poles. This is a competing point and will enable the company to get away from short-line roads which have no cars and have been unable to furnish flats to take care of the business offered. A stock of poles of all lengths and sizes will be carried at this yard to insure prompt loading of orders.

Cutler-Hammer Manufacturing Co., Milwaukee, Wis., describes and illustrates in a four-page leaflet entitled "Electric Heating of Water," the immersion and conduction types of C-H water heaters. The leaflet also compares electric heat with other methods of heating water, and gives formulas and tables whereby the size of heater desired under any particular conditions can be readily determined. Three different types of immersion heaters are described, viz., bottom outlet, pipe outlet and circulation. The former is mounted in the bottom of water container; the pipe outlet heater is used with vessels provided with pipe outlets, as they fit threaded pipes of 1.25 or 2 ins. inside diameter; and the circulation type heater is inserted in the pipe loop of a hotwater tank or other container.

Link-Belt Co., Chicago, is distributing the revised edition of catalog No. 380 covering its line of standardized monorail electric hoists and overhead electric traveling cranes in capacities of 0.5 to 3 tons, inclusive. Tables of weights, clearance dimensions and speeds are also given.

Duplex Lighting Works of General Electric Co., New York City, announce that during August, Duplex lighting installations were made in the new Hanna, Buckley and 4300 Euclid avenue buildings in Cleveland, while the National Malleable Castings building was changed over to Duplex units.

Cooper-Hewitt Electric Co., Hoboken, N. J., is distributing an 18-page booklet entitled "Studies in the Economics of Lighting," by E. Leavenworth Elliott, which treats on the different kinds of light for industrial and other purposes, pointing out how efficiency and production can be increased by the proper method of lighting.

Hurley Machine Co., Chicago, manufacturer of the Thor electric washing machines and other electrical household devices, has issued an interesting brochure entitled "You and Your Laundry," the author of which is Mrs. Christine Frederick. The booklet describes the advantages of modern electrically operated laundry equipment over the old methods and the savings that can be effected by their use. It also contains valuable information on laundry work, including how to prepare and use soap solutions; how to cleanse various fabrics most effectively; how to remove stains and set colors, and the proper arrangements of the home laundry. The hints contained in the pamphlet will prove useful to the housewife.

American Steam Conveyor Corp., 326 West Madison street, Chicago, announces a change in its corporate name to the Conveyors Corporation of America. This is brought about by the rapid growth of the company, the addition of new lines of business and the purchase at South Bend, Ind., of a completely equipped machine shop to which foundry facilities will be added. The new name better describes the present business of the organization, which includes steam jet conveyors for handling ashes, soot, combustion ash, etc., trolley carriers for coal, limestone, sand, gravel and other loose bulky materials; ash pit doors; flood oil-bearing sheaves and other conveyor supplies. There is no change either in the personnel or policy of the company.

PERSONAL MENTION

Biographical Sketches and Chronicle of Changes in Business Connections, Promotions and Other Personal News of the Industry

F. A. STEVENSON, American Telephone & Telegraph Co., New York City, has been elected a director of the Radio Corporation of America.

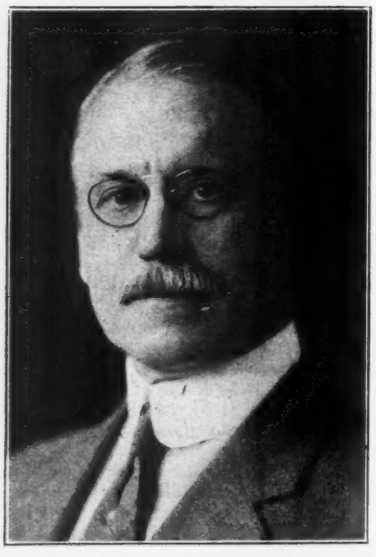
HARRY J. JOHNSON has been appointed superintendent of the Western Colorado Power Co., Telluride, Colo., succeeding George T. Bradley, resigned.

L. S. READY has been appointed chairman of the committee of the San Francisco section of the American Institute of Electrical Engineers. He is a member of the California Railroad Commission.

H. P. CLAWSON, for many years in the Chicago office of Westinghouse, Church, Kerr & Co., has been made manager of the Cleveland branch of Dwight P. Robinson & Co., in the Citizens building.

JAMES F. ABBOTT, commercial attache for the United States at Tokyo, Japan, reports that the proposed extension of hydroelectric projects in that country will necessitate the erection of about 1000 miles of high-tension transmission lines within the next two years, most of which will probably be of the steel tower type.

CHARLES E. PATTERSON, comptroller of the General Electric Co. since 1913, has been elected a vice-president. He was previously associated with the New York Central railroad and the American Locomotive Co. For nearly 25 years he has had wide experience in accounting, having aided in the development of the Interstate Commerce Commission's accounting system for railroads. He is chairman of the standing committee of the Electrical



Charles E. Patterson.

Manufacturers' Council, which evolved the standard accounting cost system for the electrical manufacturing industry.

CHARLES C. ADAMS, who retired from the vice-presidency of the Postal Telegraph-Cable Co. about a year ago, has been elected president of the Peninsula National Bank of Cedarhurst, L. I., N. Y.

CARL M. HEINTZ, Westinghouse Electric & Manufacturing Co., Los Angeles, Cal., has been appointed chairman of the publicity committee which will handle the two electrical homes to be opened in that city shortly.

F. R. WHITTLESEY has been appointed secretary of the Oregon Association of Electrical Contractors and Dealers with headquarters at Portland. He was formerly in the commercial department of the Portland Railway, Light & Power Co.

WILLIAM E. HARKNESS, for many years telephone engineer in the service of the Western Electric Co. and the Hall Switch & Signal Co., has been appointed general manager of production for the Powers Accounting Machine Co., New York City.

CHARLES S. BEARDSLEY has accepted a position with the Apex Electrical Distributing Co., Cleveland, as sales director. He will have supervision of the sales of the "Apex" electric suction cleaners and "Rotapex" electric clothes washers. Mr. Beardsley was formerly general manager of the United Electric Co., Canton, O.

GUY P. NORTON, Duplex Lighting Works of General Electric Co., New York City, who attended the Jobbers' Representatives convention at Nela Park, Cleveland, Sept. 13-15, stopped at Buffalo to address the sales force of Robertson-Cataract Electric Co., which was holding its semi-annual conference at the Hotel Iroquois.

PHILIP C. STAPLES, Philadelphia, has been appointed vice-president of the Bell Telephone Co. of Pennsylvania and will have charge of public relations and personnel matters. He has been associated with the Bell system for 16 years, a large portion of this time being spent in Philadelphia, where he recently held the position of division manager and assistant to the president.

MORSE DELLPLAIN, who was elected president of the Indiana Electric Light Association at the twelfth annual convention held last month at French Lick Springs, was born in New Orleans, La., in September, 1880. Most of his early life was passed in the Republic of Mexico. From 1890 to 1896 he was employed by the Central and South American Telegraph Co. as an operator on the Isthmus of Tehuantepec. He later took up the electrical engineering course at Syracuse University. In 1903 to 1905 he was an apprentice in the shops of the Westinghouse Electric & Manufacturing Co. at East Pittsburgh, Pa., and worked for the company as sales engineer in the Syracuse (N. Y.) office from 1905 to 1909. He became power engineer for the Syracuse Lighting Co. in February, 1909, and on Jan. 1, 1918, was appointed sales manager for the same company,

Morse DellPlain.

which position he resigned in August of the same year to become vice-president and general manager of the Northern Indiana Gas & Electric Co., Hammond, Ind. Mr. DellPlain is a member of the American Institute of Electrical Engineers and the American Society of Mechanical Engineers.

PROF. FREDERICK HAYNES NEWELL, head of the civil engineering department at the University of Illinois and former director of the United States Reclamation Service, has resigned. He directed the construction of nearly all the reclamation work carried on during the Roosevelt administration, his biggest work being the Roosevelt dam in Arizona. He also directed the building of the Shoshone dam in Wyoming.

OBITUARY.

JAMES J. GALLAGHER, one of the oldest employes of the Pacific Gas & Electric Co., San Francisco, in the easy bay region, died last month. He was in the company's service 35 years.

JAMES M. MOORE died Sept. 13 at the age of 43 years. He had been associated with the Cook Electric Co., 900 West Van Buren street, Chicago, for many years, having entered the employ of Frank B. Cook on May 21, 1906.

J. C. KEARNS, operator in the Folsom power house of the Pacific Gas & Electric Co., San Francisco, died recently. He was 56 years of age, a native of St. Louis, and had been in the employ of the Pacific company for over 20 years.

BUSINESS OPPORTUNITIES

News of Electrical Construction Projects in All Parts of the Country, Proposals Invited, Foreign Trade Openings and New Companies

EASTERN STATES.

Fairfield, Me.—Electrical and mechanical equipment will be installed in the new pulp and paper mill to be erected here by the Keyes Fibre Co., Waterville, Me. The plant is estimated to cost $100,000, and will be an extension to the existing local plant.

Cambridge, Mass. —Considerable electrical equipment will be installed in the new six-story plant of the Suffolk Engraving & Electrotyping Co., at Main and Carlton streets, Kendall Square.

Holyoke, Mass.—Electrical equipment will be installed in the addition to be erected at the plant of the Perfect Safety Paper Co.

Malden, Mass.—The Malden Electric Co., has filed plans for the erection of a one-story sub-station to cost about $15,000.

Norwood, Mass.—The Holliston Mills have completed plans for the erection of a one-story power house addition.

Springfield, Mass.—The Gilbert & Barker Co., manufacturer of gas furnaces, pumps, etc., will install considerable electrical equipment at its plant at West Springfield, construction of which is now well under way. Contracts have been let for electrical wiring and other miscellaneous work.

Ansonia, Conn.—Considerable electrical equipment and machinery will be installed at the local plant to be erected by the American Brass Co., Waterbury, Conn. The structure will be one-story, 330 by 400 ft., forming an extension to the present works, and is estimated to cost $600,000, including equipment. It will be used as a rod and copper wire works.

De Ruyter, N. Y.—The board of trustees has been granted permission by the Public Service Commission to construct and operate a local electric light and power system.

Gaines, N. Y.—The Western New York Utilities Co. has asked permission to construct an extension to its electric plant in the town of Gaines.

Glens Falls, N. Y.—The Adirondack Light & Power Corp. is having plans prepared for the erection of a building at Amsterdam, N. Y., to be located at Market and West Main streets.

Jamestown, N. Y.—The city council has awarded a contract to Paddock & Curtis, 1 Hall block, Jamestown, for the erection of a municipal electric plant and electrically operated pumping station, 70 by 112 ft., to cost about $60,000.

New Rochelle, N. Y.—The Roloc Realty Co. has been incorporated with a capital of $75,000, to construct and operate a series of power and lighting plants. The incorporators are: E., and E. S. Wittnebel, New Rochelle.

New York, N. Y.—The New York Edison Co., Fifteenth street and Irving place, has filed notice of increase in capital from $66,349,400 to $69,849,400, for proposed expansion and improvement work. A contract has been let to F. M. Madden, 1369 Broadway, for the construction of a two-story substation, 74 by 75 ft., at 120-24 Cedar street, to cost about $150,000, including equipment. Erection is under way on a one-story substation at 8 Elizabeth street, to cost a like amount.

New York, N. Y.—The New York Telephone Co., 15 Dey street, has awarded a contract to the Tidewater Building Co., 16 East 33d street, for the erection of a six-story exchange, at 121-129 West 73d street, to cost about $800,000.

New York, N. Y.—The Combustion Engineering Corp., 11 Broadway, has completed plans for the proposed power plant to be erected by the West Bend Heating & Lighting Co., West Bend, Wis. The plant will be 113 by 150 ft.

North Tonawanda, N. Y.—The Tonawanda Power Co. has arranged for a bond issue of $100,000, the proceeds to be used for extensions and improvements in stations and lines at North Tonawanda and Tonawanda.

Poughkeepsie, N. Y.—The Standard Oil Co., 26 Broadway, New York City, will build a power house in connection with a number of other buildings on a local site.

Skaneateles, N. Y.—Electrical machinery and equipment will be installed in the paper mill of the Skaneateles Paper Co., in connection with extensions and improvements to cost about $100,000.

Troy, N. Y.—The Ford Motor Co., Detroit, Mich., has made application to the Federal Power Commission, Washington, D. C., for permission to build a hydroelectric power plant in this section, to be used in connection with its proposed new tractor manufacturing works on Green Island, near Troy. The power station will have an initial capacity of about 6000 h. p. It is proposed to inaugurate immediate erection when permission is given, expected to be within the next few weeks.

Whitehall, N. Y.—The Consolidated Light & Power Co. is arranging details for the erection of a power plant.

Bayonne, N. J.—The Tidewater Oil Co., Constable Hook, has completed plans for the erection of a one-story boiler and pumping plant, 147 by 150 ft.. to cost about $85,000, including equipment.

Camden, N. J.—Construction work has been inaugurated on the power plant at the factory of the Victor Talking Machine Co. The station will be 40 by 200 ft., and with equipment will cost about $400,000.

Newark, N. J.—The George W. LeCompte Co., Mulberry street, will build a one-story power house in connection with its proposed plant on Victoria street, estimated to cost $35,000.

Newark, N. J.—John Neider, Inc., has filed plans for the erection of a one-story power house at its works at 241-43 Emmet street.

Trenton, N. J.—The new lighting installation, comprising the use of tungsten lamps, as recently suggested by Professor C. E. Caldwell, will be made by the Public Service Electric Co. Initial work has been placed under way; a total of about 643 lamps will be installed.

Trenton, N. J.—The Cook Linoleum Co., East State street, has awarded a contract to the J. H. Morris Co., Broad Street Bank building, for the erection of a one-story power house at its plant, 72 by 140 ft., to cost about $100,000, including equipment.

West Orange, N. J.—Thomas A. Edison, Inc., has awarded a contract to the American Concrete Steel Co., 31 Clinton street, Newark, N. J., for the erection of a one-story addition to its power and boiler plant, 60 by 88 ft., to cost about $80,000, including equipment.

Bath, Pa.—The Bath Portland Cement Co. is planning the installation of power-plant equipment at its local mills, including boilers and auxiliary equipment, to cost about $250,000.

Carlisle, Pa.—The Public Service Commission has granted permission to the Carlisle Gas & Water Co. to take over, through purchase, the plant and property of the Carlisle Light, Heat & Power Co.

Chester, Pa.—Electrical machinery and euqipment will be installed in the proposed steel plant to be erected in the western section of the city by the Stalium Metals Corp., recently incorporated in Delaware with capital of $2,500,000. The company has acquired 11 acres of land adjoining the present works of the American Steel Foundries. Initial plans for the plant are under way, and it is proposed to break ground at an early date. S. S. Staley is president, and Edward F. Gray vice-president.

Cheswick, Pa.—The first 60,000-kw. unit of the proposed six unit 360,000-kw. plant being erected for the Cheswick Power Co. is now nearing completion and work will shortly be started on the second unit. This construction and installation work is being done by Dwight P. Robinson Co., engineer, 125 East 46th street, New York City.

Dushore, Pa.—The Public Service Commission has approved the sale of the Dushore Electric Co. to the Sullivan County Electric Co.

Erie, Pa.—Construction is under

way on a power plant at the Doople Farms, operated as a county poor house, Fairview and Girard townships. The plant, in connection with a group of other buildings, will cost about $350,000. Address J. W. Lloyd, 730 State street, Pittsburgh.

Lancaster, Pa.—The Pennsylvania Water & Power Co. is developing a plan to dredge the deposits of coal dust on its 60-ft. dam along the Susquehanna river at Holtwood. The deposit has been formed by the washing of the coal from the mining districts in this vicinity. It is proposed to utilize the dust in the form of briquettes, and a works will be established for this purpose. E. E. Clark, president of the company, is at the head of the project.

Lansdale, Pa.—Following a number of complaints holding that the local municipal electric plant is furnishing inadequate service, the borough council is considering plans for improvements in the station, to insure uniform service. It is contemplated to install a new electric unit for emergency and peak-load service, with auxiliary equipment. The installation is estimated to cost in excess of $55,000.

Philadelphia, Pa.—The Orinoka Mills, Ruth, near Somerset street, has completed plans for the erection of a power house at its plant, to be located at Sterner and Jasper streets, and estimated to cost $100,000.

Philadelphia, Pa.—The Franklin Worsted Co., Venango and C streets, has filed plans for the erection of an addition to its power house.

Philadelphia, Pa.—The Foss-Hughes Co., Twenty-first and Market streets, will make improvements at its power house.

Philadelphia, Pa.—Electrical machinery and equipment will be installed in the plant of the Fox Motor Co., Broad and Huntingdon street, to be located at Seventh and Grange streets. The J. S. Rogers Co., Drexel Building, has the construction contract.

Baltimore, Md.—The Columbia Graphophone Co. has completed plans for the erection of a pumping plant and compressor building at its new factory in the Orangeville district, to cost about $25,000. A large power station will also be erected for general works service.

Baltimore, Md.—In connection with the proposed additions to its local oil refining plant, estimated to cost $2,000,000, the Standard Oil Co., Pratt and Commercial streets, will build a large power and boiler plant. The present output of 6000 barrels per day at the works will be considerably increased through the installation of new machinery.

Baltimore, Md.—The Consolidated Gas, Electric Light & Power Co., has completed plans for the construction of a one-story, electrically operated pumping plant, 57 by 200 ft., at Race and Barney streets. The company has also filed plans for improvements in its building at 105-15 North Liberty street.

Baltimore, Md.—The Electro-Mechanical Co. has filed plans for extensions and improvements in its plant on North Calvert street.

Baltimore, Md.—The City Board of Awards has completed plans for the installation of new equipment at the power plant of the Bayview Hospital, to comprise pumps, boiler apparatus, etc. General improvements will also be made in the station.

Port Deposit, Md.—The Port Deposit Electric Co., which has been operating on an eight-hour light supply schedule, has increased the service to include 18 hours; the hours for operation are from 6 a. m. to 12 midnight.

Westport, Md.—The Consolidated Gas, Electric Light & Power Co. has completed plans for the construction of a switching plant here, to be one story, 35 by 76 ft.

Barton Heights, Va.—The Chesapeake & Potomac Telephone Co., Richmond, Va., will install telephone lines with cables, at an estimated cost of $18,000.

Lynchburg, Va.—The Chesapeake & Potomac Telephone Co. will install 400 additional lines at a cost of $11,000. The company will spend $6,500,000 on extensions and improvements in Virginia during the next three years.

Richmond, Va.—The Chesapeake & Potomac Telephone Co., Washington, D. C., has arranged an appropriation of $6,500,000 to be expended in Virginia during the next 36 months for extensions and improvements. In the Richmond territory, $18,000 will be expended for new cable and underground conduit lines in the Barton Heights district; new material will be installed to improve the long-distance service at a cost of $11,000. At Norfolk, about $30,000 will be used for new cable installations, and an aerial cableway, and $14,000 will be expended for immediate line betterments. It is planned to install additional lines at Lynchburg to cost about $11,000, and a fund of $14,000 will be used for improvements at Danville.

Beckley, W. Va.—The Beckley Electric Light & Power Co. has increased its capital stock from $75,000 to $200,000. Improvements will be made to the plant.

Blueville, W. Va.—The Brownlow Service Co. has been organized to install electric light and water systems at Brownlow Park. Address B. M. Parrish, superintendent, Grafton, W. Va.

North Wilkesboro, N. C.—The city council has arranged for a bond issue of $30,000 for the installation of an electric lighting system, to be operated in conjunction with a municipal waterworks.

Arlington, Ga.—The Baker County Power Co. has perfected plans for the erection of its proposed hydroelectric power plant in this section. The proposed station will have an initial capacity of about 3000 hp. and is estimated to cost $650,000, including machinery and line equipment. The new plant will connect Arlington, Camilla, Edison and Moultrie, and will furnish service in these districts. W. E. Saunders is secretary and treasurer.

Griffiin, Ga.—The Sibley Electric Co., recently organized, will operate local electric light and power system. J. F. Sibley is head.

Rebecca, Ga.—The town council is considering the installation of an electric light and power system.

New Smyrna, Fla.—Bonds for $53,000 have been approved by the city council for the installation of equipment at the local power plant, and improvements in the lighting system.

Rochelle, Fla.—The city council has approved a bond issue of $45,000 for extensions and improvements to the municipal power plant.

NORTH CENTRAL STATES.

Ironton, O.—The Kelly Nail & Iron Co. plans to erect a one-story and basement power plant at its works, 40 by 60 ft.

Carson City, Mich.—The city council has had plans prepared for a new municipal power plant to cost about $150,000. Address The Fargo Engineering Co., Jackson, Mich.

Jackson, Mich.—The Hayes Wheel Co. will erect a one-story power and boiler plant, 60 by 60 ft., at an estimated cost of $40,000.

Lansing, Mich.—Bonds to the amount of $610,000 have been voted by the citizens for public improvements, $145,000 of which is to be used for the electric lighting plant.

Mendon, Mich.—The United Electric Co. of Burr Oak has been furnishing power to this village, but on account of poor service the residents plan to ask the Three Rivers Co. to supply them with the necessary current. The Michigan Gas & Electric Co. is trying to buy out the United Electric Co., but if unable to do so complete new equipment will be installed.

Indianapolis, Ind.—The Republic Creosoting Co. plans erection of a power plant at its works.

Indianapolis, Ind.—The Electrical Transmission Co. of Northern Indiana plans to construct a transmission line 25 miles long between Warsaw and Goshen at an estimated cost of $50,000.

Warsaw, Ind.—The Winona Electric Light & Water Co. has increased its preferred stock from $100,000 to $200,000.

Chicago, Ill.—The Great Western Laundry Co., 2319 West Madison street, plans to install a power plant in connection with its new laundry.

Chicago, Ill.—The Sanitary District of Chicago has awarded a contract for the erection of a power plant to cost $543,000 at 124th street and South Michigan avenue to the T. J. Forchner Contracting Co. The plant is in connection with the Calumet-Sag works.

Decatur, Ill.—Bids were received Sept. 27 for the construction and installation of an ornamental lighting system on and along the curb line on each side of Cobb avenue. Address Charles M. Borchers, mayor.

Pana, Ill.—Plans are under consideration for the installation of cluster lights for Kitchell avenue. Address City Engineer Stanfield.

Tacoma, Ill.—The Consumers' Central Heating Co. plans the erection of a power and heating plant at an estimated cost of $200,000.

Carlinville, Ill.—The Chesterfield Electric Co. plans to light the village of Chesterfield, using current brought in from the Keokuk circuit. The town of Medora will also have electric lights supplied by a newly-or-

ganized company which will bring in current over a high tension wire from Greenfield. William Finch is interested in the latter proposition.

Waukegan, Ill.—Progress has been made by the committee of the local chamber of commerce, to which was delegated the authority of seeing local property owners in the business district with a view to obtaining their consent to the ornamental street lighting improvement.

Gotham, Wis.—A survey has been made for a dam on the Wisconsin river, two miles east of here. The Southern Wisconsin Power Co. and the Wisconsin River Power Co., G. C. Neff, manager, Gay building, Madison, Wis., are interested in the project.

Marshfield, Wis.—The Electric Light and Water Commission has been investigating electric plants in the state. It was recommended that the city continue to run its own plant here and also that the bids filed for the new equipment be accepted.

Port Wing, Wis.—The Northern Wisconsin Hydroelectric Power Co. will erect a hydroelectric plant and dam on Iron river, the plans for which have been prepared by J. C. Jacobson, engineer, 533 Metropolitan Bank building, Minneapolis, Minn. Address T. N. Okerstrom.

Sheboygan, Wis.—The St. Nicholas Hospital has completed plans for the erection of a power plant to cost about $35,000. Address P. Reiss, chairman of the board of directors.

Sparta, (Angelo), Wis.—The Angelo power plant was destroyed by fire recently, causing a loss of $20,000. The light and power service will be reduced as the generating plant is unable to carry the load required for local consumption. It will require a month to put in a temporary plant capable of carrying the load.

Cyrus, Minn.—Bids were received Sept. 27 for the construction of an electric light system for the village. Address L. L. Hanse, village recorder.

Hugo, Minn.—An electric lighting system will be installed here at a cost of $1800. The Hugo Improvement Club, of which Hector A. Pepin is secretary, is interested in the proposition.

Milan, Minn.—An electric light and power company is being organized here to build high line to Appleton. Oliver Haugland is interested in the proposition.

Rushford, Minn.—The Rushford Power Co. will extend its lines to Peterson.

Two Harbors, Minn.—The city has voted an extension of the telephone line on Maple street, between First and Eleventh avenues, to be erected by the Duluth and Iron Range Railroad Co., H. H. Brickley, superintendent.

Grant, Ia.—The borough council is having details and estimates worked out for the erection of a municipal power plant. The funds required for the project will be raised by a bond issue.

Maquoketa, Ia.—This city is to be a unit in an extensive development project begun by the Iowa Railway & Light Co. and the Iowa Electric Co. Sites have been purchased for the erection of two power plants.

Independence, Mo.—Owing to the fact that the municipal light plant is unable to furnish power to the Waggoner-Gates Milling Co., the Kansas City Electric Light Co. has been asked to run a line into this city for the purpose of furnishing current for power to the mill.

Mt. Vernon, S. D.—The plant of the Mt. Vernon Light & Power Co. burned recently, causing a loss of $5000.

Pierre, S. D.—The state hydroelectric commission will erect a dam at Mobridge, S. D., or at Mulehead ranch in Rosebud reservation for a Missouri river hydroelectric project. Bonds to the amount of $15,000,000 will be voted for the proposition.

Sioux Falls, S. D.—A hydroelectric plant will be erected on the Missouri river at an estimated cost of $16,000,000. Address Walter Leyse, city clerk.

Cando, N. D.—The city may purchase an electric lighting plant. Address W. A. Martin, manager of the City Light Commission.

Valley City, N. D.—The city plans to erect a 48 by 91-ft. addition to its power plant.

Van Hook, N. D.—The city will enlarge its electric light plant.

SOUTH CENTRAL STATES.

Blackey, Ky.—The Dudley Coal Co. plans to construct a power house.

Georgetown, Ky.—At the general election there will be presented a bond issue of $150,000, to be used for the installation of a municipal electric power plant, operated in conjunction with a waterworks system.

Le Center, Ky.—The LeCenter Light & Power Co. has increased its capital stock from $5000 to $10,000.

Louisville, Ky.—A number of coal-mining companies in different parts of the state are planning the erection of power plants at their properties for general mining service. These include the Dudley Coal Co., Blackey; the Marion Coal Co., David; and the Ulvah Coal Co., Bluefield. The last two noted are also planning the construction of coal tipples.

Memphis, Tenn.—The United States Gas & Electric Co. plans to make improvements to its electric plant to increase production. The estimated cost is $190,000.

Smithville, Tenn.—The city council has plans under way for the construction of a new transmission line to connect with the station of the Great Falls Power Co. at Rock Island, about 18 miles; connection will also be made with the system of the Tennessee Power Co., at Falls City. The project is estimated to cost $75,000.

Dothan, Ala.—The common council has plans under way for the establishment of a municipal power plant on the Choctawhatchee river.

Mobile, Ala.—The Kelly Drydock & Shipbuilding Co. is planning the erection of an electric power plant at its yard to cost about $150,000, including equipment. E. L. Whitney is president.

Newton, Miss.—Plans are under way for extensions and improvements in the local light and power system. In connection with waterworks improvements, about $35,000 will be expended.

Eureka, Ark.—The city commissioners will install a street-lighting system.

Walters, Okla.—The city commissioners have approved the outlay of $105,000 for improvements to the light system, sewer and waterworks. Address city commissioners.

Abilene, Tex.—The Abilene Gas & Power Co. plans erection of a power plant.

Cleburne, Tex.—The city will install steam turbines, 150 hp. electric motor and 1,250,000-gal. daily capacity compressor. The estimated cost is $200,000. Address J. W. Hockaday, superintendent of water works.

Dallas, Tex.—According to J. L. Strickland of Dallas, president of the Texas Electric Railway, all but $1,500,000 of the total of $5,000,000 first mortgage bonds for the construction of the proposed interurban electric railway between Dallas and Wichita Falls have been placed. The financial interests back of the project have until Dec. 1 to place the entire amount.

Eastland, Tex.—The Southwestern Telephone Co. is erecting a new building at a cost of $100,000.

Edinburg, Tex.—The Public Utilities Co. is planning the erection of an electric lighting plant on a local site. An ice-manufacturing plant will also be constructed.

Lubbock, Tex.—Percy Ralls is interested in the installation of an electric light plant at this place.

Moran, Tex.—The Albany Light & Stone Quarry Co., Albany, plans to extend its power transmission line to Moran and to install a lighting system here. It also is arranging to build a water works plant at Moran to cost $90,000.

San Angelo, Tex.—The San Angelo Water, Light & Power Co. plans to install additional equipment in its plant here. It will also improve its power transmission system which runs to Miles, Rowena, Ballinger and Winters.

San Benito, Tex.—The San Benito Electric Light & Power Co. has been incorporated with a capital of $50,000, to operate a local light and power system. The incorporators are C. G. Malott, J. T. Lomax and R. M. Graeter, San Benito.

WESTERN STATES.

Brigham City, Utah.—Bonds to the amount of $200,000 have been voted to rebuild and enlarge the municipal light plant.

El Dorado, Cal. — The El Dorado Exploration Co. plans to install modern machinery, using electricity for motive power. Address William W. Milne, general manager.

Bandon, Ore. — Application has been made to the state engineer by the city for permission to divert 25 second feet of water from Wilson creek for power purposes, the plans to include a 1000-kw. power plant.

Bend, Ore. — The Bend Water, Light & Power Co. will construct the first unit to its plant on the Tumalo river, which will cost $100,000 and develop 2000 hp. The company will put in 40,000 ft. of pipe. The second unit will cost $150,000 and develop 3000 hp. A pipe line 12,000 ft. long will be installed.

FINANCIAL NEWS

Comment on the Financial Outlook in the Electrical Industry, New Securities, Reports of Earnings, Dividends and Utility Stocks

Detroit Edison Co.'s Earnings for July and August.

The gross earnings of the Detroit Edison Co. for July and August totaled $1,674,617 and $1,689,129 respectively, an increase of about 37% over the corresponding months of 1919. It was during these two months that the company suffered from the accident to one of its turbines which cut down generating capacity by about 25%. A new generator in the place of the one which was shut down is now being installed.

For the seven and eight months' periods ended July 31 and Aug. 31. 1920, the gross revenues amounted to $11,983,120 and $13,672,949 respectively, an increase in both periods of 32% over the corresponding periods of last year. The deduction of interest charges resulted in deficits of $40,436 and $68,956 for July and August. The surplus after charges for the eight months to Aug. 31 amounted to $956,558. The rate increase which went into effect July 1 approximates a 17% advance on the general schedule.

American Power & Light Co.'s Subsidiaries.

Net earnings from operation of all subsidiary operating companies for July showed $461,482, an increase of 7% over the same month last year. Gross totaled $1,650,157, an increase of 35% over July, 1919. Net for the 12 months ended July 31 showed $7,042,223, an increase of 26% over the corresponding period last year. Gross amounted to $10,035,911, an increase of 26% over the previous year.

Offering of Cleveland Electric Illuminating Co. Stock.

An issue of $4.000.000 8% cumulative preferred stock of the Cleveland Electric Illuminating Co. is being offered by William A. Read & Co. at 100 and accrued dividend. A sinking fund of 2% per annum of the total amount issued is provided for the purchase of stock up to 105 and accrued dividend.

Railway & Light Securities Co.

Reports of the Railway & Light Securities Co., Boston, for the 12 months ended July 31 show a total income of $293,000; profit after taxes, expenses, etc., $158,737; gross income, $171,446, and surplus after dividends. $21,446.

Southern California Edison Co.

	1920.	1919.
August gross earnings	$1,528,108.94	$ 972,974.69
Expenses and taxes	642,129.32	386,264.72
Net earnings	885,979.62	586,709.97
Fixed charges	278,402.68	253,948.57
Balance	607,576.94	332,761.40
For 12 months ending Aug. 31, 1920:		
Gross earnings	12,860,505.98	9,852,321.59
Expenses and taxes	5,754,989.45	3,858,113.43
Net earnings	7,105,516.53	5,994,208.16
Fixed charges	3,080,300.38	3,093,579.29
Balance	4,025,216.15	2,900,628.87

Option Offered on Stock of Wesetrn Power Co. of Canada.

Stockholders of the Western Power Co. of Canada, Ltd., have been advised that interests are seeking an option on the preferred and common stocks of the company. The option price is stated to be $70 a share for the preferred and $35.10 for the common stock, payable in Canadian currency. At the request of several large holders of stock a committee composed of Bayard Dominick and M. H. Coggeshall has entered into an agreement with the Chartered Trust & Executor Co., Toronto, whereby the latter is given an option until Nov. 1 on all stock which may be deposited.

Stockholders desiring to avail themselves of this agreement are requested to deposit their stock with the Canadian Bank of Commerce. Upon the deposit of at least 56.27% of the common and 51.99% of the preferred the terms of the option will be carried out. It is understood that inability of the company to do new financing on favorable terms, which is necessary to provide funds for additions and extensions, makes the entry of new interests into the affairs of the company desirable.

United Light & Railways Co.

Comparative consolidated earnings statement of the company and its subsidiaries for 12 months ended Aug. 31:

	1920.	Increase.
Gross, all sources	$11,421,633	$1,606,580
Parent company's balance available for dividends	1,381,146	271,664
Pro rata preferred dividends	603,258	*2,942
Surplus earnings	777,888	274,607

*Decrease.

Utah Securities Corp. and Subsidiaries.

	1920.	1919.
August gross	$ 695,212	$ 604,779
Net earnings	321,009	304,507
Twelve months' gross	8,077,363	7,094,821
Net earnings	3,862,076	3,702,704

Portland Railway, Light & Power Co.

	1920.	1919.
July gross	$ 806,131	$ 698,065
Net after taxes	247,537	264,725
Surplus after charges	60,207	71,275
Twelve months' gross	8,936,112	8,318,130
Net after taxes	2,797,557	2,745,958
Surplus after charges	536,026	480,764

Manhattan Electrical Supply Co.

For the eight months ended Aug. 31, the gross earnings were $5,121,333, against $4,340,776 gross for the corresponding period a year ago, a gain of more than 18%. The net for 1919 was $102,910.

Bonds of Consumers Power Co. Offered to the Public.

An issue of $2,500,000 Consumers Power Co. general and refunding mortgage 15-year 7% gold bonds, series "B," dated July 1, 1920, due July 1, 1935, is being offered to the public by the National City Co., Cassatt & Co. and Graham, Parson & Co. The price is 91.25 and interest, yielding 8.5%.

Dividends.

The Massachusetts Lighting Companies has declared its regular quarterly dividend of $1.50 on the preferred stock, payable Oct. 15 to stockholders of record Sept. 25.

The Northern Ohio Traction & Light Co. has declared its regular quarterly dividend of 1.5% on the preferred stock, payable Oct. 1 to stockholders of record Sept. 10.

The Detroit Edison Co. has declared its regular quarterly stock dividend of 2%, payable Oct. 15 to stockholders of record Sept. 30.

The American Power & Light Co. has declared its regular quarterly dividend of 1.5% on the preferred stock, payable Oct. 1 to stockholders of record Sept. 23.

The Harrisburg Light & Power Co. has declared its regular quarterly dividend of 1.5% on the preferred stock, payable Sept. 30 to stockholders of record Sept. 17.

The Washington Water Power Co. has declared its regular quarterly dividend of 1%, payable Oct. 15 to stockholders of record Sept. 24.

The Duquesne Light Co. has declared its regular quarterly dividend of 1.75% on the preferred stock, payable Nov. 1 to stockholders of record Oct. 1.

The American Gas & Electric Co. has declared its regular quarterly dividend of 2.50%, payable Oct. 1 to stockholders of record Sept. 16.

The Central States Electric Corp. has declared its regular quarterly dividend of 1.75% on the preferred stock, payable Oct. 1 to stockholders of record Sept. 10.

WEEKLY COMPARISONS OF CLOSING-BID PRICES OF SECURITIES OF LEADING ELECTRICAL COMPANIES.

Quotations furnished by F. M. Zeiler & Co., Rookery Bldg., Chicago.

Public Utilities—	Div. rate. Per cent.	Bid Sept.21.	Bid Sept.28.
Adirondack Electric Power of Glens Falls, common	6	13	14
Adirondack Electric Power of Glens Falls, preferred	6	70	70
American Gas & Electric of New York, common	10+extra	92	91
American Gas & Electric of New York, preferred	6	35	36
American Light & Traction of New York, common	..	112	123
American Light & Traction of New York, preferred	6	81	82
American Power & Light of New York, common	4	46	45
American Power & Light of New York, preferred	6	68	68
American Public Utilities of Grand Rapids, common	..	6	6
American Public Utilities of Grand Rapids, preferred	7	14	14
American Telephone & Telegraph of New York	..	100½	99
American Water Works & Elec. of New York, common	..	2	2½
American Water Works & Elec. of New York, particip	7	4	4
American Water Works & Elec. of New York, 1st preferred	..	38	39
Appalachian Power, common	..	1	1
Appalachian Power, preferred	7	13	14
Cities Service of New York, common	extra	293	296
Cities Service of New York, preferred	6	66	66
Commonwealth Edison of Chicago	8	101	100
Comm. Power, Railway & Light of Jackson, common	..	15	16
Comm. Power, Railway & Light of Jackson, preferred	6	36	36
Federal Light & Traction of New York, common	..	6	6
Federal Light & Traction of New York, preferred	..	42	41
Northern States Power of Chicago, common	..	30	30½
Northern States Power of Chicago, preferred	ex.div.7	75	76
Pacific Gas & Electric of San Francisco, common	..	48	48
Public Service of Northern Illinois, Chicago, common	7	65	64
Public Service of Northern Illinois, Chicago, preferred	6	83	84
Standard Gas & Electric of Chicago, common	..	12	13
Standard Gas & Electric of Chicago, preferred	6	35	35
Tennessee Railway, Light & Power of Chattanooga, common	..	1	1
Tennessee Railway, Light & Power of Chattanooga, preferred	6	2	2½
Western Power of San Francisco, common	..	18	18
Western Union Telegraph of New York	extra	87	88
Industrials—			
Electric Storage Battery of Philadelphia, common	4	121	118
General Electric of Schenectady	8	143	140
Westinghouse Electric & Mfg. of Pittsburgh, common	7	48	49